ROADS and STREETS

Vol. 82, No. 5 May, 1939

A GILLETTE PUBLICATION
ESTABLISHED 1906

WORLD'S DEEPEST BOTTOM-DOOR TYPE OPEN-WELL CAISSONS BEING SUNK IN SURGING TIDE STREAM OF TACOMA NARROWS

Swift Deep Rough Water Major Problem of Contractors and Engineers, Who Have Displayed Ingenuity in Solving

By VICTOR J. BROWN
Publishing Director,
ROADS AND STREETS.

SINKING the deepest bottom-door type open well caissons in the world in the surging, rushing riptides of Tacoma Narrows is the job undertaken by Pacific-General-Columbia, the contractor on the 5000 ft. suspension span bridge for the new highway to cross an arm of Puget Sound just southwest out of Tacoma, Washington. To fully appreciate the force of the tide flow which at times attains a velocity of 7 miles per hour (over 10 ft. per second) one should see it cataract around the ends of the caisson and construction barges.

On the only bridge where a similar tide flow has been encountered, the Golden Gate bridge, the foundation problem consisted of a single pier 100 ft. below surface of water, whereas the depth below water of the Tacoma Narrows caisson type piers will be 200 ft. on the east pier and 175 ft. on the west one. The major construction problem is the control of the caissons and construction equipment in the high velocity, rough, deep water of the Narrows. Even as this was being written a derrick barge steel anchor cable, 1¼ in. in diameter, snapped during the evening and the swift current crashed the boat into an anchor barge on which a diesel engine and an air compressor were standing, causing the barge to roll over and sink. The machinery is lost; the barge can be recovered but at considerable expense.

For many years the people of Tacoma and Pierce County have wanted a bridge to reach the vast Olympic Peninsula. Opportunity for the fulfillment of this desire was realized when the Washington legislature, in 1937, created the Washington Toll Bridge Authority. Feasibility studies projected shortly afterward took form in an application to the Public Works Administration for a 45 per cent grant of the estimated $6,400,000 project. The Reconstruction Finance Corporation loaned the balance, $3,520,000, on revenue bonds created to complete the financing.

Pacific-General-Columbia, the contractor, is a combination of the Pacific Bridge Company of San Francisco, Calif., the General Construction Company of Seattle, Wash., and the Columbia Construction Company of North Bonneville, Wash. Their bid was on a total basis for $5,949,730.40. They have sublet the suspension cable spinning and superstructure steel work to the Bethlehem Steel Company, but will do all substructure work themselves, except the east anchorage which has been sublet to Woodworth and Cornell, contractors of Tacoma, Wash. They started work on November 23, 1938, and the job must be completed on June 30, 1940.

The streets of Tacoma will be connected to the east end of the project. The west end will be carried to a junction with the existing state highway system on the peninsula. Following is a tabulation of the lengths of the bridge portion:

1.	East anchorage	170 ft.
2.	East approach	175 ft.
3.	East side span suspension bridge	1,100 ft.
4.	Main span suspension bridge	2,800 ft.
5.	West side span suspension bridge	1,100 ft.
6.	West approach	450 ft.
7.	West anchorage	144 ft.
	Total length	5,939 ft.

The anchorage on the east end is 70 ft. wide and lies under the toll gates at the beginning of the east approach. What may appear to the layman as the east anchorage, will be the east approach span which will be a concrete trestle enclosed by a concrete curtain wall to make the whole appear as a solid abutment. The west anchorage, while not so long as the east anchorage (but of the same width) will also contain 25,000 cu. yd. of concrete.

General Construction Plan

Open-well bottom-door type caissons have been adopted as the method of establishing footings for the main piers. The foundation upon which the footings will rest when in final position is a bed of coarse gravel. Simultaneously, the pier footings for the west approach will be constructed by open pit digging. Reference to Fig. 1 will establish the pier numbers. The accompanying progress chart, Fig. 2, shows the proposed plan of construction procedure. At this writing, the caisson for Pier 4 has been floated to position, tied to the anchors and sinking is in progress. An isometric drawing, Fig. 3, shows the general idea of the caisson construction. There has been some minor changes made since this drawing was finished, but the main characteristics are correctly shown.

Caisson Anchors.—In a circle around the caisson center 24 massive concrete anchors have been spotted on the bottom of the Narrows. They are placed according to a definite arrangement which may be explained by using compass directions. On Pier 4, for example, let us call the long axis North and South.

A circular line approximately 460 ft. from the center of the caisson would establish the center line of the anchors. Anchors W1, W2, W3, and W4, would be west, two on each side of the prolonged minor axis and evenly spaced about 50 ft. apart on centers. Of course, all predetermined positions are exactly calculated, but by the time one of the 600 ton (out of water weight) reinforced concrete blocks gets to the bottom through 120 ft. of racing tides it generally misses the calculated position, sometimes as much as 18 ft. At the long radius employed, this is negligible. Progressing clockwise in plan view are NW1 and NW2 opposite the short corner face of the caisson. N1, N2, N3, and N4 are opposite the end face, then comes NE1 and NE2. Out from the other long side of the east face of the caisson are E1, E2, E3, and E4 in the clockwise direction, on to SE1 and SE2, then to S1, S2, S3, and S4, opposite the south end of the caisson. Finally, SW1 and SW2 complete the circle of 24 anchors.

Each anchor has two eye connections projecting from the end toward the caisson. To the lower one, the end of a 350 ft. steel bridge strand, 1 9/16 in. in diameter, is attached before the anchor is dumped. After it sinks to position the other end of the bridge strand cable is connected to a double set of falls attached in V-shape to two points on the lower edge of the faces of the caisson. The V-set falls are so reeved that the lead lines extend vertically up the side of the caisson to clamps at the top edge. The loose ends are coiled on top and laid on a runway. To adjust the anchor line lengths for securing the proper tension in them and thus for obtaining the correct positioning of the caisson, the lead lines are "taken in" or "slacked off" as required. This operation is accomplished by clamping a "come-along" over the loose end of a lead line. The "come-along" is attached to the free end of a caisson derrick load line and the derrick pulls or slacks as directed after the anchor line caisson clamp is loosened. When the tension is adjusted the anchor line caisson clamp is tightened again.

From the upper eye of the anchor block a similar anchor line arrangement is attached to eyes near the top of the caisson about 12 ft. below the water line. Similar anchor lead lines are also attached to the top edge of the caisson. They are adjusted in the same manner as the lower anchor lines except that the attachment to the caisson must be shifted as the caisson sinks so as to keep the connection, at all times, near the water surface. The connections are shifted by divers. The shifting plan has been studied and worked out in considerable detail. One must never forget the power and force of those surging tides when shifting the top connections. The taut, anchor lead lines fairly

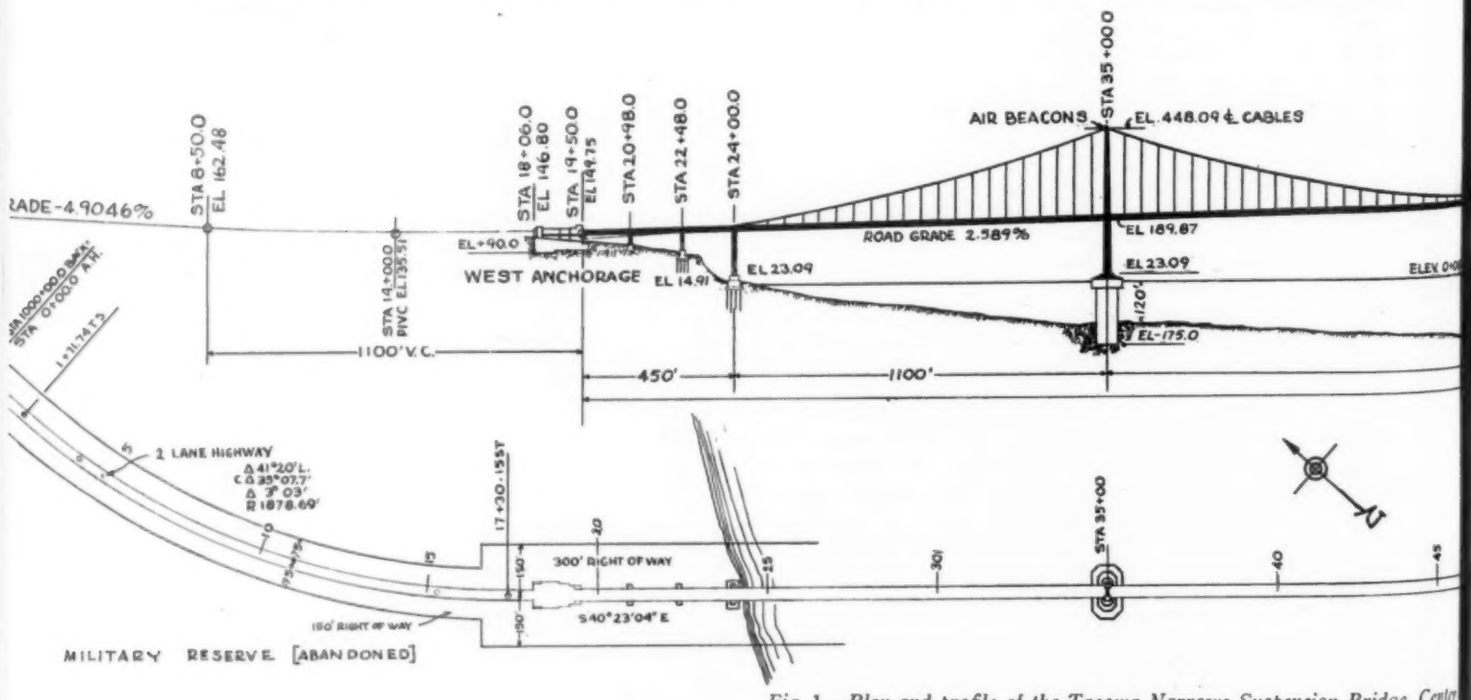


Fig. 1.—Plan and profile of the Tacoma Narrows Suspension Bridge. Cente

sing in the swirling, rushing water. The drawing, Fig. 4, shows the anchorage connection plan.

In order to increase friction of the anchors with the bottom, they are built with corrugated faces as shown by Fig. 5. They were built in place on 5 specially constructed scows and towed to position by tugs. Figure 6 shows the spotting of one of the anchors.

In order to get the anchors dropped on the predetermined points, in exactly the right place, two transitmen, one for line and one for stadia distance, on the shore, direct the positioning with a two-way radio set. Another two-way radio set is on the tug which maneuvers the anchor scow. When in position the order is given to open the seacocks and pull the plugs. Another tug does this, thus flooding one compartment of the scow, listing it to one side, and allowing the anchor to skid off. Divers are then sent down to check the landed position on the bottom of the Narrows. The skidways on the anchor scow are not greased since one anchor was lost in a rough sea, while being towed to the site, when the skidways were greased.

After all anchor cables are in place and fastened to the top of the caisson, the latter is then adjusted to position by tightening or loosening, as required, of the free ends of the fall lines. As the draft increases during the concreting, naturally greater stresses will be put on the anchor lines. The caisson, also, will tilt slightly from side to side as concreting proceeds and as the construction of the pier progresses, moving it out of position. In order to have a definite knowledge of the stresses on the anchor lines during positioning operations, a strain gauge was devised by Mr. Theodore M. Kuss, the contractor's chief engineer, to hook between the free end of the anchor lead line and the derrick load line. The strain gauge was built by the contractor and calibrated at the laboratory of the University of Washington. It is a giant of the typical ring type strain gauge. A picture of it is shown in Fig. 7.

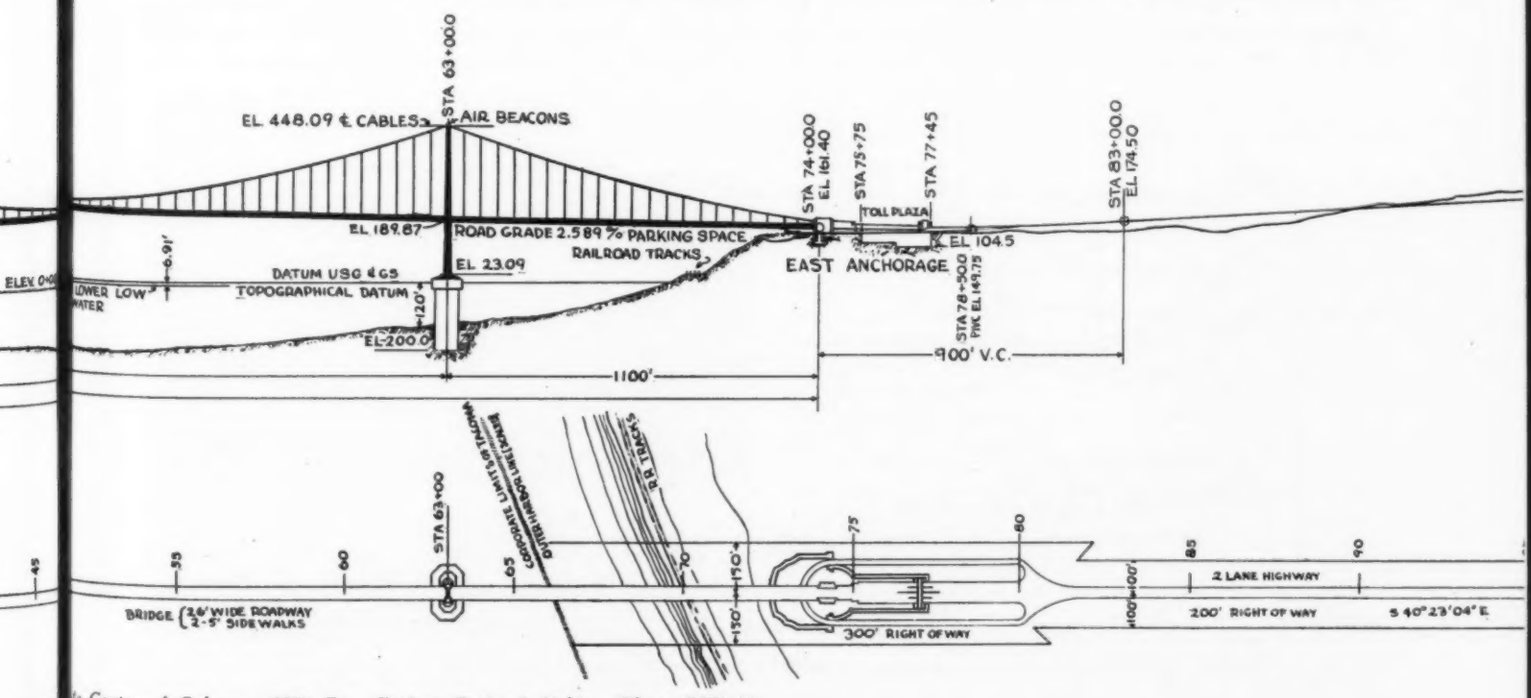
The caisson must land, i.e., strike bottom exactly right the first shot. The moving currents are bound to cause some slack in the anchor cables so no chances can be taken of overstressing or breaking any cable in the tightening process. The caisson must remain perpendicular at all times. Complete equilibrium studies have been made and pull forces calculated for the various tilting angles. Figure 8 shows one of the construction tipping studies. Other equilibrium investigations have indicated overturning moment values. All analytical computations are being checked by scale model tests at the Hydraulic Laboratory of the University of Washington.

Caisson Piers.—As sinking proceeds, sand and water will be introduced in the cells to act as ballast and, incidentally, to help to relieve some of the pressure on the false bottoms. The bottom of the Narrows where Pier 4 is to be landed is practically level. The bottom at Pier 5 has a 25-ft. cross-slope difference in elevation. This difference will be leveled off before Pier 5 caisson is towed to position. It was here that the clam shell derrick boat anchor line broke, causing the loss of an anchor barge and machinery.

It is practically impossible to refloat a caisson once it is landed. However, it can be done. The flooded and ballasted cells can be emptied and as the 14-ft. tide comes in, the caisson could be refloated. But once it is landed so that the cutting edge will not penetrate more without bottom excavation, and should the surging tides or a storm shift it out of place, it would be practically impossible to refloat it.

The caisson pier forms which are made out of 8 in. by 12 in. timbers are erected in panel sections 12 ft. high after the inner steel truss work has been erected. When the caisson is landed, the false bottom will be pulled and excavation will proceed with clamshell buckets through the open wells that will be flooded to water level.

False Bottom.—The design of the boat bottom of the caisson is ingenious. The cutting edge (itself a massive structural unit) and the first stage of the caisson with a novel false bottom installed, made a boat out of it so it could be towed through Puget Sound to the site at Tacoma Narrows. The first stage construction of the caisson included pouring the first 12 ft.



to Center of Caissons, 2800 Ft.; End to End of Bridge Floor, 5450 Ft.

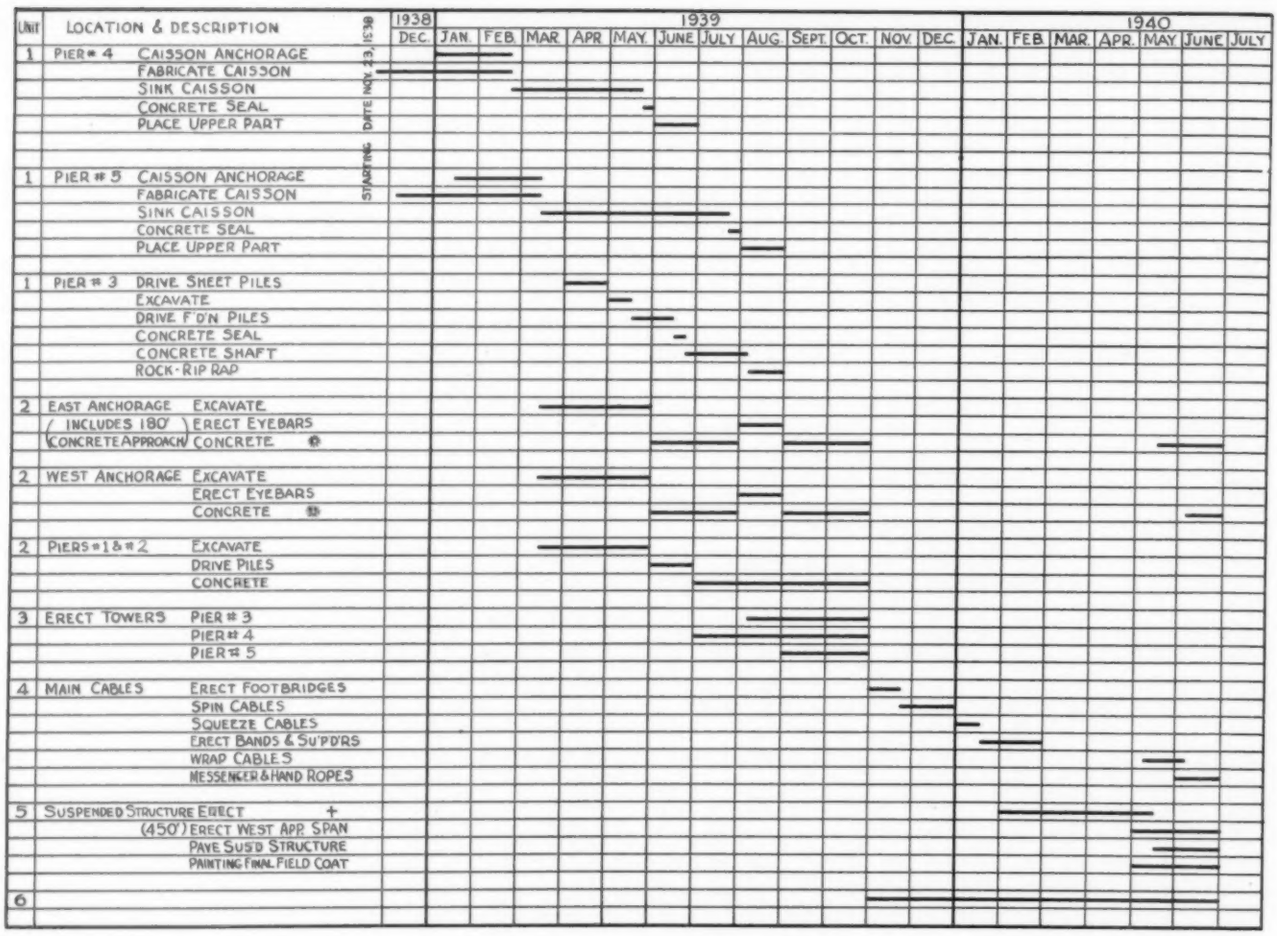


Fig. 2.—Progress Chart.

of concrete between the forms of the hull and in the cell walls. Fabrication of the various parts up to this point was done by the Pacific Car and Foundry Co. on the structural work at its Renton plant; the Drummond Lighterage Co. on Elliott Bay for the assembling; the Lake Washington Ship Yard for the false bottom and the caulked 8 by 12 wood shell forms, and the Todd Dry Dock for the launching. Each caisson is 118 ft. 11 in. long and 65 ft. 11 in. wide. The interior cells are 11 ft. 10 in. by 13 ft. and open to the bottom. Concrete encases the structural steel framing of the cell trusses and girders. Figure 9 is a picture of the

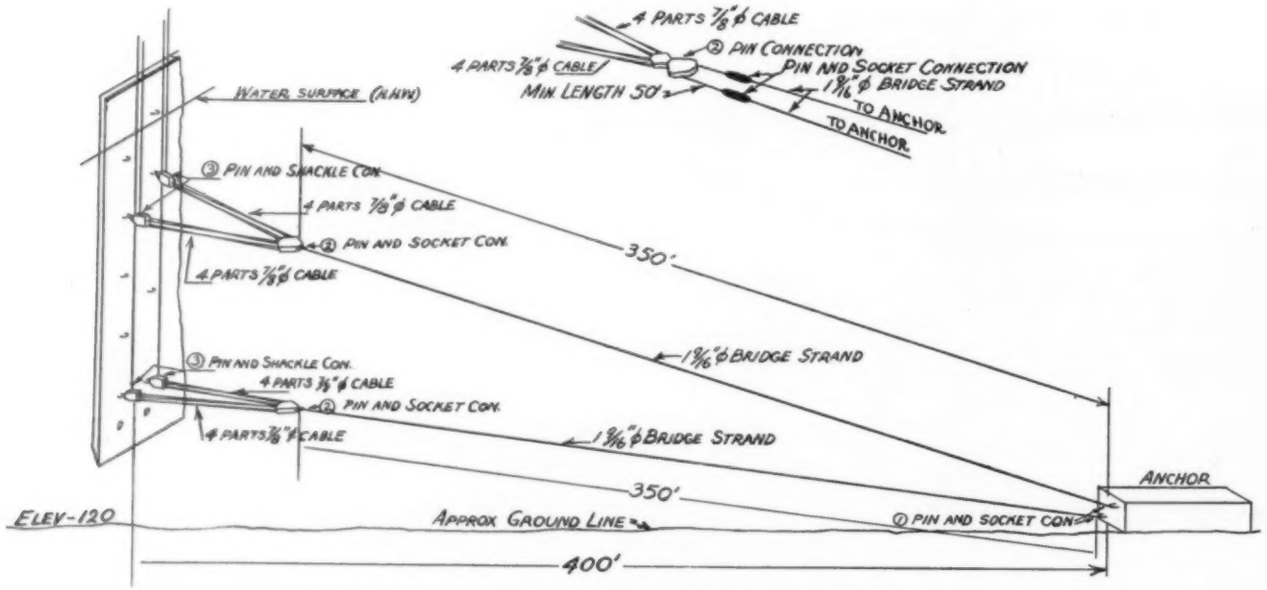


Fig. 4.—Showing How the Anchors Are Attached to the Caisson.

caisson being towed to position.

The false bottom is difficult to describe. Referring to Figs. 10 and 10A, it may be seen that two knee braces hold a pair of butting thrust timbers from buckling. These thrust timbers, two 8 by 10's, laid flat side by side on each end, rest on a 20 in. by 20 in. by 12 ft. 6 in. timber that acts as a stringer against which the pressure of the false bottom floor is exerted. Directly beneath the 20 by 20 timbers is a tight flooring of 8 in. by 12 in. timbers laid flat. Beneath these is a coating of asphalt, and at right angles to the first set of 8 x 12 floor timbers is another set of 4 in. by 12 in. flooring, laid flat. All seams are caulked. A layer of canvas seals the joints between the floor and the steel cutting edge wall. This canvas seal is shown in Fig. 11.

When the caisson is landed and the wells have been flooded, a rope line and hook is dropped to take hold of the cable loop. A pull by the hoist will jerk all timbering loose, as may be seen by reference to Fig. 10, and all woodwork will be brought to the top. The false bottom timbering is all tied together either with wire rope or bolted strap iron.

Excavations.—Pier 4 will be founded 175 ft. below low-tide water surface and Pier 5 will extend to 200 ft. below the surface. After the false bottom is completely removed, clamshell buckets will be dropped through the 120 ft. of water to start digging, removing sand, sandy clay, and hard pan until the stable, predetermined, solid gravel bed is encountered. Should a boulder too large to be handled by the bucket be encountered, a diver will be sent down to place a dynamite charge on it sufficient to break it so it can be removed. Similar action will be taken for tight boulders that may be encountered under the cutting edge. Excavation will be wasted outboard.

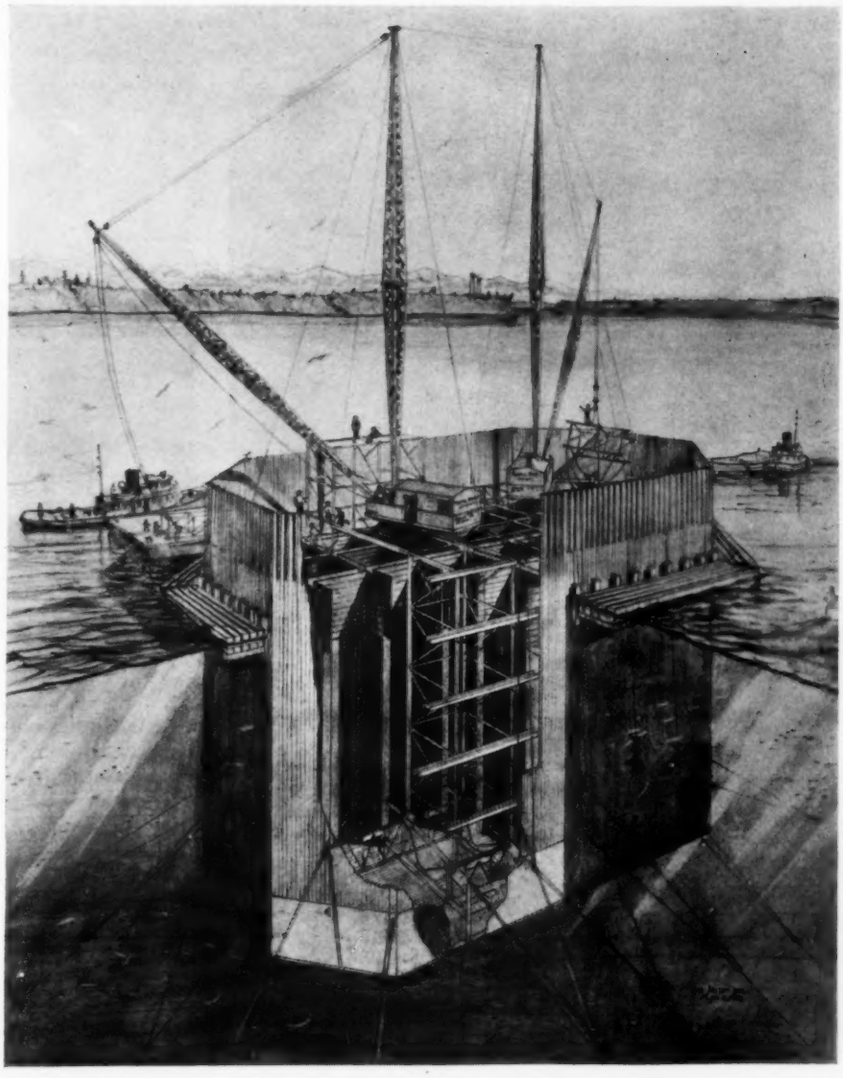


Fig. 3.—Isometric View of Pier Caisson Showing Main Characteristics of Construction. The Lines Leading Outward Tie to 600-Ton Anchors. Around the Outside Is a Tug Bumping Fender for Construction Protection. The False Bottom Will Be Jerked Out When the Caisson Is Landed. Two Revolving-Power-Plant, Specially-Built, Guy Derricks Which Raise Each Other, Alternately, Handle All Lifting and Placing of Steel, Forms, and Concrete, Besides Taking Up Slack in Anchor Cables as the Caisson Lowers.

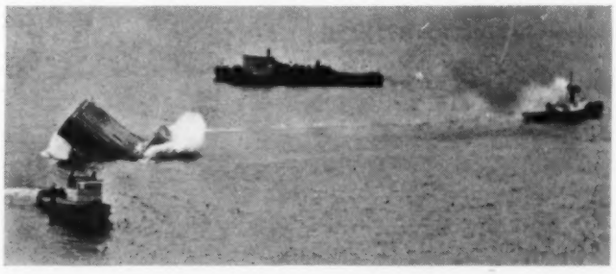


Fig. 6.—When in Position, the Anchors Are Dumped Off the Scow by an Ingenious Flooding Plan Which Sinks One Side of the Scow. Seacocks Under the Water Line Are Opened and the Tug at the Right Pulls Out Two Safety Plugs on One Side, Permitting Water to Flood One Compartment and Dump the 600-ton Anchor. The Barge in the Background Acts as an Anchor for the Anchor Scow. The Tug in the Foreground, Which Is Equipped With a Two-Way Radio Set for Getting Instructions From the Transitmen on the Shore, Who Also Have a Two-Way Radio Set, Maneuvers the Anchor Into a Precalculated Position.

When the cutting edge of caisson-pier 4 gets down to elevation minus 170.0 and No. 5 to minus 195.0, the design requires a footing to be excavated 5 ft. lower out to the sides of the caisson under the cutting edge. From the construction point of view this raises a question as to whether or not skin friction on the outside of the caisson will be sufficient to hold it in place during footing excavation and concrete placing.

As a safety precaution, one plan of footing excavation contemplates first digging out the footing 5 ft. below the cutting edge in the center wells and pouring these to a point 20 ft. above the cutting edge. In this case, after the concrete has set, the load of the caisson, assuming there is no skin friction, will be carried on the center well footings and walls as the outside wells are excavated.

When the first stage of concreting was done while the caisson was still on barges at the Lake Washington Ship Yard, 3 in. by 12 in. continuous shear keyways, shown by dotted lines in Fig. 12, were built into all walls

Fig. 5.—Anchors Are Poured in Place on a Specially Built Scow. Note the Corrugated Facings. Each Anchor Is 12 ft. by 12 ft. by 51 ft. 6 in. of Concrete Reinforced With Steel Cables, Steel Rods, and Railroad Rails. They Are Towed Into Position by a Tug and Spotted by Transit and Stadia Instruments on the Shore Before Being Dumped From the Scow.

Fig. 7.—Giant Strain Gauge Devised to Read the Stress on Anchor Lines While Adjusting the Caisson to Position.

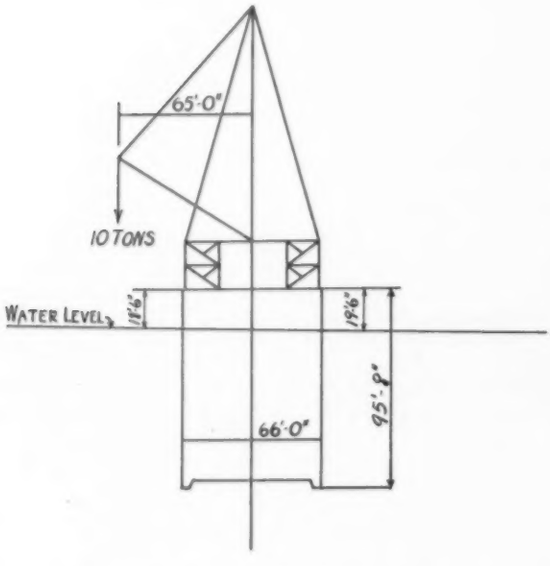


Fig. 8.—Caisson Tipping Due to Rig Loads.

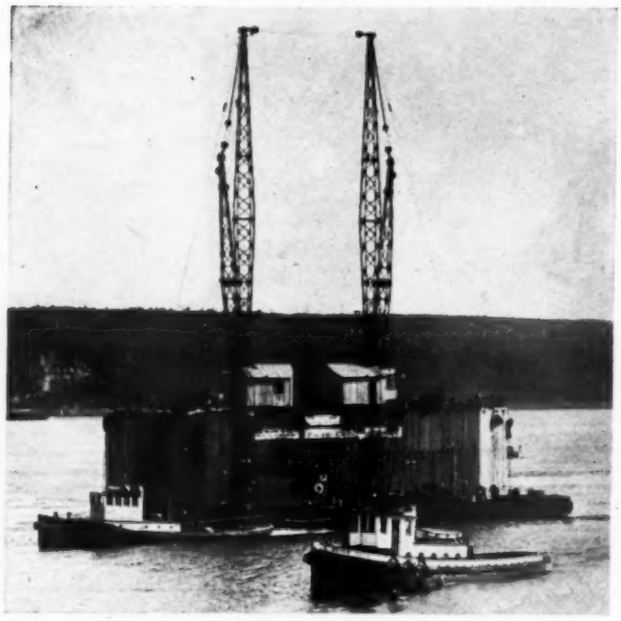


Fig. 9.—Caisson for Pier 4 Being Towed to Position, Like a Boat or Barge.

about 15 ft. above the cutting edge. These were installed to give additional safety against settlement of piers in the concrete footing and seal. As the fresh concrete rises in the seal it will fill in under the caisson walls and in the shear keys provided.

Continuing this method of footing construction, after the concrete has hardened the outside cells will be excavated. Since the clam shell cannot reach beneath the cutting edge, it is planned to send a diver down with an hydraulic monitor to scour the walls away far enough outward to give a solid concrete bearing for the cutting edge. Similar to the center cell digging after a point is reached at least 5 ft. below the cutting edge, concrete will be poured to finish the 25-ft. thick footing and seal.

After the footing seal has hardened the caisson will be capped with concrete 20 ft. thick to receive the steel

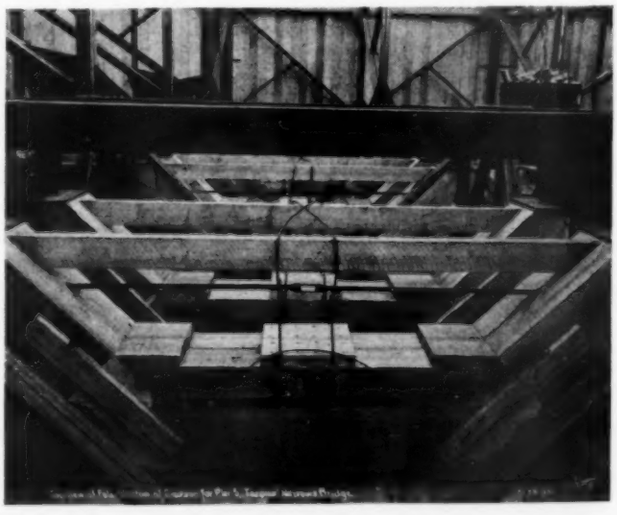


Fig. 10.—View of the Details of the False Bottom Arrangement. When the Caisson Is Landed a Hook Is Dropped to Take Hold of the Cables and by Pulling From the Hoist on Top, the Whole False Bottom Is Pulled Out Through the Cell Wells. All Timbering Is Tied Together by Cable or Strap Iron. Note the Cut Timber Stringer With Ends Butting Tightly Together. All Joints of the False Bottom Are Caulked.

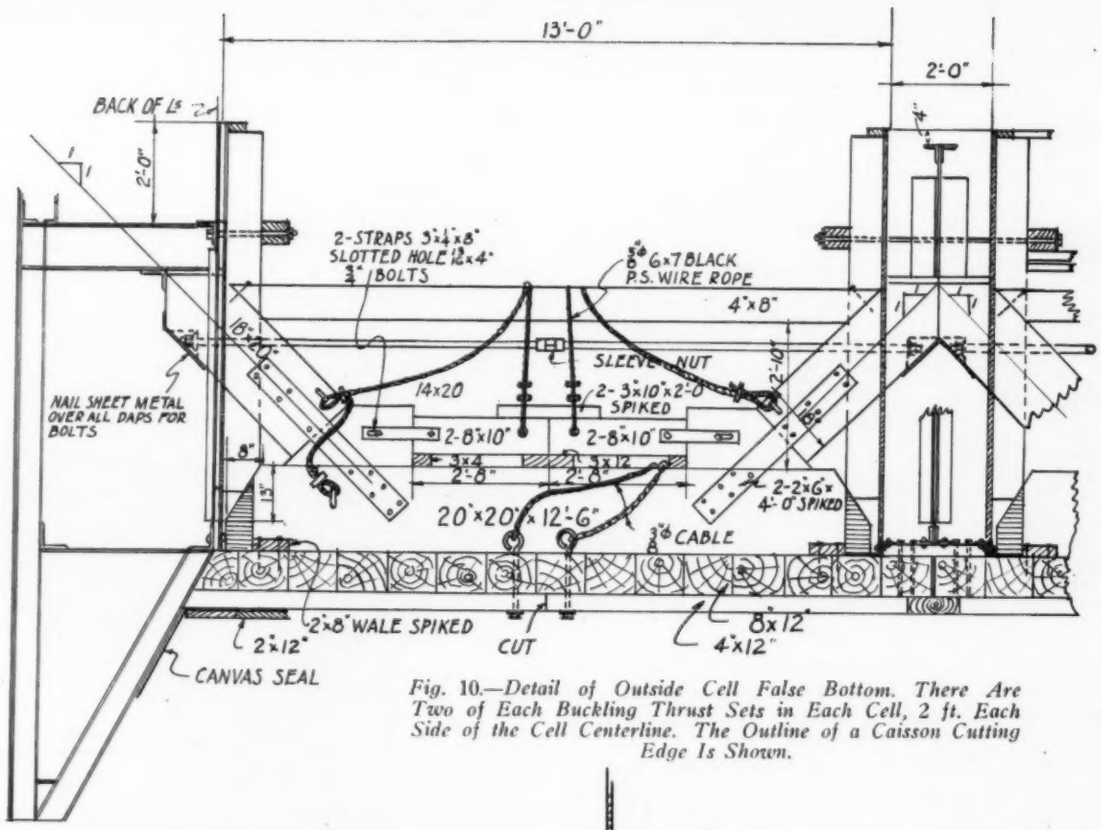


Fig. 10.—Detail of Outside Cell False Bottom. There Are Two of Each Buckling Thrust Sets in Each Cell, 2 ft. Each Side of the Cell Centerline. The Outline of a Caisson Cutting Edge Is Shown.

towers. The piers have been designed to withstand the entire weight of the bridge, wind forces, wave forces, and ship impact. Figure 12 shows a half section of the bottom.

Towers.—Fabricated steel towers will rise to a height of 425 feet. Each tower will consist of two shafts, which, together, will cover an area 19 ft. by 63 ft. at the bottom and 13 ft. by 52 ft. at the top. A maintenance and inspection elevator will be installed in each tower.

Concrete Plant.—Pier 3 is on the edge of the west shore line of the Narrows. The center of the slip under the concrete mixing plant is 192 ft. from the center of this pier. Since concrete must be barged to the caissons

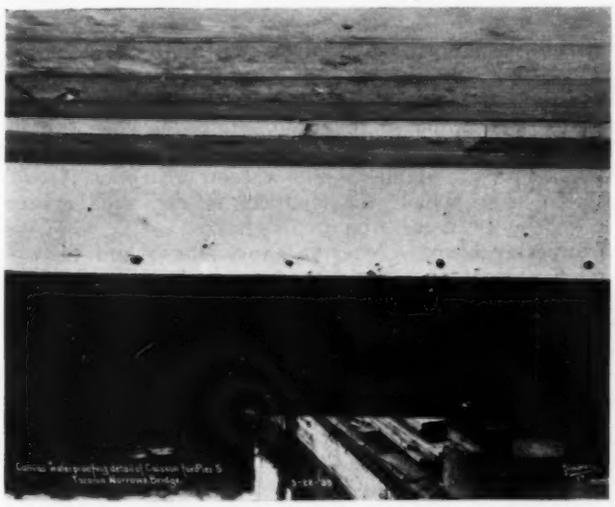


Fig. 11.—View Showing Canvas Seal Between False Bottom and Cutting Edge. The Canvas Is Made Fast to the Cutting Edge With Rubber Cement.

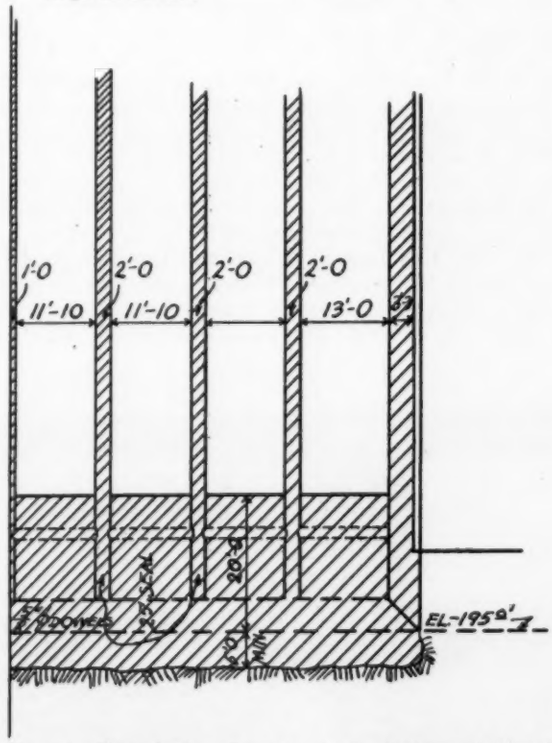


Fig. 12.—Half Section Drawing of the Bottom of Pier 5 Through the Longitudinal Axis.

and their footings, the mixing and proportioning plant was established on a dock. The bulk cement supply barges are tied to the trestle dock on the shore side from which cement is pumped to the twin silos. Sand and gravel barges are tied to the channel side of the dock.

The size and capacity of all concrete equipment and operations were established by the engineers' requirement of a production rate of 80 cu. yd. of mixed concrete per hour. The engineers deemed this output

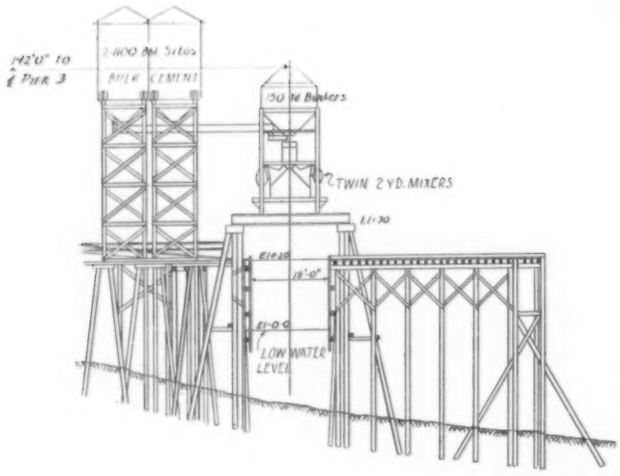


Fig. 13.—Contractor's Layout of Concrete Mixing and Proportioning Plant. Bulk Cement Barges Are Tied Up on the Shoreside of the Dock While Sand and Gravel Supply Barges Are Tied on the Channel Side. A Crane, Not Shown in the Sketch, Transfers the Aggregates From the Barges to the Storage Bin.

necessary to insure fresh concrete over the entire area at all times. Five concrete barges are required for pouring Pier 5 which is farthest from the mixing plant.

The contractor's plan of the concrete plant setup is shown by Fig. 13. Figure 14 is a picture of the mixing plant, showing Caisson 4 in the background. A small part of the top of the slip can be seen. Figure 15 is a closer view of the mixer plant arrangement. A crane loads the aggregates into the 3-compartment, 150 cu. yd. bunker from which it is weighed and dropped into the chute that feeds the twin 2-yd. mixers. A cement bin is not shown, nor is the water tank visible. The mixers feed and dump alternately into an 8 cu. yd. hopper. Two outlets from this hopper empty into funnel-topped elephant snouts that may be slid out of the way to permit passage through the slip of the concrete barge towing tug. An 8 cu. yd. concrete bunker is required so that four concrete buckets on a concrete barge may be filled each time one pulls in.

Fig. 14.—Concrete Plant Setup. Caisson for Pier 4 Is Shown in the Background. Two Koehring 2-yd. Mixers Are Fed by a Johnson 3-Compartment Bin. A Bulk Cement Bin and Water Storage Tank Are Not Visible. Cement Is Piped to the Bin Through the Extended Pipe Shown at the Right. Scales and Proportioning Equipment Are Shown. Mixed Concrete Is Dumped by Each Mixer Into the Receiving Hopper Below. Elephant Snouts Are Attached, Which May Be Slid to One Side to Permit Passage of Concrete Barge Tug Through the Slip. Each Barge Carries Four 3-yd. Concrete Buckets.

Four sets of 5-pile dolphins at 16 ft. centers provide a guide-way to the slip at each end. The trestle with tram car track from the mixing plant back to the approach piers and west anchorage is on a 50 per cent maximum grade.

Each loaded concrete barge carries 4 concrete buckets of the contractor's design. The buckets, which hold a little more than the 2 cu. yds. of concrete, are held in place on the barge by steel-plate-faced vertical trusses, 4 for each bucket, on planes at right angles to each other. The trusses are made of 8 in. by 8 in. timbers and are 8 ft. high. Each barge has stalls for 6 buckets. One each trip to a caisson, two buckets of the four loaded ones are left there, so that when the next loaded barge arrives at

Fig. 15.—Close View of the Mixing Plant.

the caisson these two will have been emptied and can be lowered into the two open stalls on the loaded barge.

Buckets are provided with a lifting bail, a conical bottom, and radial gate dump. Each barge is 52 ft. long, 16 ft. 8 in. wide, and 4 ft. 4 in. deep. The buckets of concrete are dumped into a central hopper on the caisson from which the concrete is deposited where needed by means of 9 cu. ft. buggies.

Superstructure.—After the anchorages and Piers 4 and 5 are completed and the towers in place, the two suspension cables will be started. On this bridge a bold engineering step has been taken in the design of width with respect to length of span. Mr. C. H. Eldridge, Bridge Engineer, provided the following information:

Bridge	Length Main Span	Width c to c of Cables	Ratio
San Francisco Bay.....	2,310 ft.	66 ft.	35 to 1
Golden Gate	4,200 ft.	90 ft.	47 to 1
Tacoma Narrows	2,800 ft.	39 ft.	72 to 1

Heretofore accepted practice for a slenderness ratio

HIGHLIGHTS OF THE TACOMA NARROWS BRIDGE

1. *Location*
   a. *Pierce County, Washington, across Tacoma Narrows at the City of Tacoma.*
2. *Facilities*
   a. *Roadway*
      (1) *One concrete roadway 26 ft. 0 in. wide.*
      (2) *Two concrete sidewalks 5 ft. 0 in. wide.*
      (3) *Capacity—two lines of 20-ton trucks.*
      (4) *Approach grade—2.589 per cent.*
   b. *Waterway*
      (1) *One central opening 2700 ft. horizontal, 195 ft. vertical.*
      (2) *East opening—650 ft.*
      (3) *West opening—1030 ft.*
3. *Bridge*

	Length
a. *East Anchorage*	170 *ft.*
b. *East Approach*	175 *ft.*
c. *East Side Span Suspension Bridge*	1,100 *ft.*
d. *Main Span Suspension Bridge*	2,800 *ft.*
e. *West Side Span Suspension Bridge*	1,100 *ft.*
f. *West Approach*	450 *ft.*
g. *West Anchorage*	144 *ft.*
Total Length	5,939 *ft.*
Total Length Suspension Bridge	5,000 *ft.*

4. *Construction Features*
   a. *Main Piers*
      (1) *Bottom door, reinforced concrete caissons.*
         (a) *Width* ..... 65 *ft.* 11 *in.*
         (b) *Length* ..... 118 *ft.* 11 *in.*
         (c) *Height East Pier* ..... 223.09 *ft.*
         (d) *Height West Pier* ..... 198.09 *ft.*
      (2) *The east pier complete weight—58,360 tons in air.*
      (3) *Each caisson is temporarily held in place by twenty-four 600-ton anchors of reinforced concrete connected by cables to the caisson.*
   b. *Main Towers*
      (1) *The two main towers over each pier are of structural steel, 19 ft. by 63 ft. in plan at bottom, and 13 ft. by 52 ft. in plan at top and are 425 ft. high.*
      (2) *Each weighs 1,875 tons.*
   c. *Main Cables*
      (1) *Bridge is carried by two 17¼ in. cables 39 ft. 0 in. on center.*
      (2) *Each cable contains 6,308 No. 6 wires.*
      (3) *The total weight of main cables is 3,817 tons.*
   d. *Floor System*
      (1) *Two 8 ft. 0 in. stiffening girders 39 ft. 0 in. centers and suspended from the main cables carry the structural steel floor beams, stringers, and concrete roadway.*
      (2) *The total suspended weight is 11,250 tons.*
   e. *Main Cable Anchorage*
      (1) *Each anchorage consists of a block of concrete containing approximately 25,000 cu. yds. of concrete and weighing 52,500 tons.*
5. *Quantities*

a. *Excavation*	
(1) *Wet*	53,000 *cu. yds.*
(2) *Dry*	137,850 *cu. yds.*
b. *Structural Steel*	20,650,000 *pounds*
c. *Concrete*	111,380 *cu. yds.*
d. *Reinforcing Steel*	3,500,000 *pounds*
e. *Cable Wire and Fittings*	8,500,000 *pounds*
f. *Concrete Pavement*	5,200 *sq. yds.*
g. *Pier Fenders*	1,230,000 *bd. ft. timber*

6. *Contractors*
   a. *Pacific Bridge Co. of San Francisco*
   b. *General Construction Co. of Seattle*
   c. *Columbia Construction Co. of Bonneville*
7. *Financial*

a. *P.W.A. Grant*	$2,880,000
b. *R.F.C. Loan*	3,520,000
Total	$6,400,000

8. *Completion*
   a. *Construction Undertaken* ..... *November 23, 1938*
   b. *Completion Date* ..... *June 30, 1940*
9. *Engineers*
   a. *Washington Toll Bridge Authority*
      (1) *L. V. Murrow, Chief Engineer, Olympia, Wash.*
      (2) *Clark H. Eldridge, Bridge Engineer, Tacoma, Wash.*
10. *Consultant Board*
   a. *Charles E. Andrew, Seattle, Wash.*
   b. *R. B. McMinn, U.S.B.P.R., Portland, Ore.*
   c. *Adm. Luther E. Gregory, Olympia, Wash.*
   d. *R. H. Thomson, Seattle, Wash.*

Mr. Clark H. Eldridge, Bridge Engineer.

Mr. Ralph Keenan, Project Manager for P-G-C.

Mr. Theodore M. Kuss, Contractor's Engineer.

has been in the nature of 35 to 1. A special truss arrangement of the floor system has been designed to provide the necessary stiffness to keep side deflections within the limits of good design.

The two suspension cables will be 17¼ in. in diameter at 39 ft. centers. They will be spun of 19 strands, with 332 No. 6 wires per strand. The usual stiffening trusses will be replaced with stiffening girders, 8 ft. deep, which will support the floor. A 5¼ in. thick reinforced concrete floor has been designed.

To complete the project, the approach trestles and viaducts will be built and the approach roads paved. A roadway on the east will branch off the main route before the toll gates are reached and be located completely around the east approach. This will give access to a view of the Narrows under the bridge.

Personnel

For P-G-C, Ralph Keenan is project manager. He has had many years' experience with the Pacific Bridge Co. Jack Graham is construction superintendent and brings to this job his experience on the Golden Gate Bridge. Theodore M. Kuss is chief engineer for the contractor. Mr. Wm Brophy is the contractor's office manager.

For the Washington Toll Bridge Authority, Mr. Lacey V. Murrow is chief engineer. He is also Director of Highways for the State of Washington. Mr. Clark H. Eldridge is bridge engineer of the project. Mr. V. G. Haner is design engineer; Mr. Fred Dunham, field engineer, and Mr. F. W. Starkey, the affable office engineer.

Mr. Charles E. Andrews, formerly bridge engineer of the San Francisco Bay Bridge, and at one time bridge engineer for the Washington State Highway Department, is chief consulting engineer.

ON PAVEMENT PATCHING

SKILL REQUIRED TO PRODUCE SMOOTH PATCH

BY R. H. BALDOCK
Chief Engineer, Oregon State Highway Commission

THAT all pavements will become rough is axiomatic. Roughness inevitably results from cuts made in surfacing or movements caused by stresses due to applied loads and due to rapid changes in the temperature. Likewise roughness results from surface movements due to frost boils and last, but not least, to grade settlements. That characteristic of a pavement mostly desired by the traveling public is smoothness. Since highways now must serve high-speed traffic, smoothness of surface is an important consideration. Rough pavements, particularly on curves, tend to cause a vehicle to leave the surface at high speeds. It is absurd to design highways for the other factors related to the selected speed such as alignment, grade, vertical and horizontal sight distance, and to neglect the obvious need of smooth surfaces.

The service life of pavement surfaces are affected by: (1) Functional obsolescence, and (2) structural deterioration. In our past highway construction, most of the functional obsolescence has been due, generally, to the increase in speed. The public demands highway free from sharp curvature. Logical recommendations have been proposed that highway designs be based upon selected speeds, since there appears to be a limit to speed, even with modern vehicles, due to the nervous reaction time of human beings. There seems to be agreement among authorities that for highways designed and constructed for a safe speed of 70 miles an hour, reasonably long life, so far as functional obsolescence is concerned, may be anticipated.

Having established this point, the factor of structural deterioration must be studied. Structural deterioration,

Paving Plant in Operation

Rolling Patch

in a large measure, may be minimized by maintaining original surface smoothness through skilled patching procedure. This statement, of course, presupposes that the original pavement has been constructed with the best knowledge available as to drainage and adequate foundations to withstand statutory loads. Right here it might well be inserted, that agreements should be reached among the states on standard vehicle loadings for wheel loads, axle loads, axle spacings, and total loads. Width, height and length are likewise a part of this needed uniform standard.

Repairing Breaks

Increased loadings, unforseen poor drainage, higher speeds, foundation settlement, and the necessity for making openings in a pavement, all require patching of the surface. With a popular demand for smoothness and speed, Oregon has developed a procedure of patching on its 4,197 miles of paved or oiled highways, that keeps the surface nearly as smooth as when originally constructed. Of this mileage, 696 miles are bituminous concrete; 1,087 miles, bituminous macadam; 2,167 miles, oiled macadam; and 347 miles, portland cement concrete. Both penetration and plant mix methods are used for repairing the bituminous pavements. Penetration patches are made by the regular routine maintenance section crews. This type of patch is not used on the higher type pavements except in cases of emergency or for a temporary expedient.

For penetration patches, uniformly graded stone or crushed gravel from 1¼ to ¼ in. is shot with hot asphalt, oil, or tar, from asphalt kettles equipped with a power spray. Approximately 17 to 20 gal. of asphalt per cu. yd. of stone are used. The hot asphalt is

Patch Partially Finished

promptly covered with smaller stone and screenings from ¼ in. size to dust. Considerable care is taken with the edges and no point of the patch is left having a variation of more than ⅛ in. in 10 ft. across the patch.

Plant Mix

Eight moving extra gangs make the repairs with plant-mix patches during the spring and summer months. Portable plants at present in use were designed and built in the state highway department equipment shops. They are mounted on pneumatic-tired trailers. Each consists of two 1000-lb. batch drums capable of producing 100 tons of bituminous concrete mixture in a 7-hour shift. Additional equipment required is one 300-gal. asphalt heater; one 100-gal. asphalt heater; one 6-ton roller and trailer; and six 1½-ton dump trucks. About 30 men, all trained on this kind of work, are needed to operate the outfit economically.

Plant mix patches, in addition to being used to raise slight depressions to maintain perfect smooth riding qualities in the surface, are used to patch breaks. They are feathered out to a paper-thinness and worked until a straightedge shows not more than ⅛-in. variation in 10 ft. Of course, on vertical curves, where a long depression has been raised, the curvature is maintained skillfully so that a motorist cannot tell when a patch is crossed without looking. Mixtures are varied to approximate the texture of the bituminous surface covered.

These hot, plant-mix patches are used on all types of surfaces, portland cement concrete, as well as bituminous. The secret of their success lies in the skill developed by the workmen in producing smooth patches. From a study of a ten-year record of patching, the goal of which has been smoothness of ridability, it appears that pavement life may be continued indefinitely, provided functional absolescence does not force major changes.

Roughness of surface is overcome by excellent smooth siding, stable patching. And this generates public good will.

▼

1939 MONTANA NATIONAL BITUMINOUS CONFERENCE—Plans have been completed for holding the 1939 Montana National Bituminous Conference at Sun Valley, Idaho, Sept. 11th to 13th inclusive. Invitation to hold the meetings at Sun Valley was extended by the Idaho Highway Department which will cooperate in putting on the conference.

From Our Readers

DENISON & DENISON
Railroad, Road and Levee Contractors
Las Vegas, N. M.
Box 86
March 27, 1939.

Roads and Streets,
330 South Wells St., Chicago, Ill.

Dear Sir: On your editorial page of the March issue of ROADS AND STREETS you had an article on equipment sales policies.

As a contractor, I wish to ask if you do not think that the equipment people have not placed themselves in the position to where the well financed contractor as well as the poorly financed contractor expects to take advantage of their sales policy, in view of the fact that on a rental basis they can buy just as cheap as if they paid cash.

But the contractor faces the fact that the equipment companies will sell to the government, and enable them an advantage to compete with them in construction work, from 25 to 37½% off of list price.

Personally, I think that 75% of the contractors would arrange to pay cash if they were given the same treatment for cash as the equipment companies have given the government.

I think that you should call the equipment companies' attention to this fact; that they are showing partiality to the government; that they are not giving the contractor, who in the past has made their business possible, a fair show.

Yours very truly,
F. ROSS DENISON.

▼

80-TON TRAILER TRUCK

An interesting recent development in the heavy duty truck field is the completion by the Dart Truck Co. of Kansas City, Mo., of a tractor-truck 10½ ft. wide, 10 ft. high and about 25 ft. long. It is designed to haul a semi-trailer of 80-ton payload capacity. The chassis weighs approximately 35,000 lbs. Combined weight of chassis, trailer and load is in excess of 112 tons. This unit is operating over private roads in the coal mining area near Hume, Mo.

The truck is powered with two 6-cylinder Hercules

Truck Trailer Outfit of Hume-Sinclair Coal Mining Co.

gasoline engines, Model HXE, 5¾ in. x 6 in. The engines are equipped to operate with butane for the fuel. Attached to each one of the engines is a large General Electric generator. Each generator drives a 125 h.p. motor and each electric motor drives one of the tandem rear axles. With no mechanical connection between the engine and the driving wheels, starting and stopping are reported to be exceptionally smooth. A shift lever is required only for forward and reverse.

OBSERVATIONS BY THE WAY

By
A. PUDDLE JUMPER

¶ To prevent snow slides in Oregon, Maintenance Engineer Bishop tried out the stunt of erecting strong woven wire fences on the hillsides parallel to the road. The fences in the views

herewith are 38 in. high, set one foot off the ground. Wire cables, about ⅜ in. diameter, are strung top and bottom of the fence and the fence

fastened to them. One and one-half inch steel pipe posts are set on 8 ft. centers and are occasionally anchored back to dead men. Bishop says they have proved very effective. These pictures were taken on the Santian Highway, between Salem and Bend, near the summit of the Cascade at elevation about 4,500 ft.

¶ All states in the Union might well look toward Oregon to see how to patch paving. Nowhere else can I recall, where anybody, state, county, township, or city, has done as excellent a job of patching as has been done in Oregon. Smoothness of riding is the object of the crews. They certainly know how to make smooth patches. A pavement, black top or p. c. concrete, can be full of patches yet ride like a new surface. Congratulations, Sam Baldock!

• •

¶ Herewith a view of a "last survivor." This is a puncheon road in Lane County, Oregon. A puncheon

road is one paved with split logs, flat side up. No, it's not a corduroy road. A corduroy road employs full round trees or sapling trunks.

• •

¶ While Oregon has a great deal for which to be complimented, they may well be criticized for those 30-mile-an-hour curves. All 1938 and 1939 model roads have beautiful curvature; but the older models are terrible. Fix 'em up, Oregon. Cut out a mile or so of new pavement and straighten out many miles of curves.

¶ A barricade on the new Oregon mountain road in California. I must admit this is not typical but it was the only barricade the foreman erected. It is on the inside shoulder

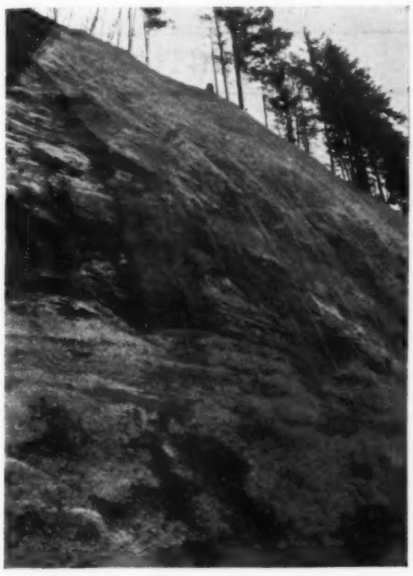
of the roadway. It carries the crayon words "Road Closed." Some barricade. I would have missed it altogether except that Resident Engineer Ward pointed it out to me.

• •

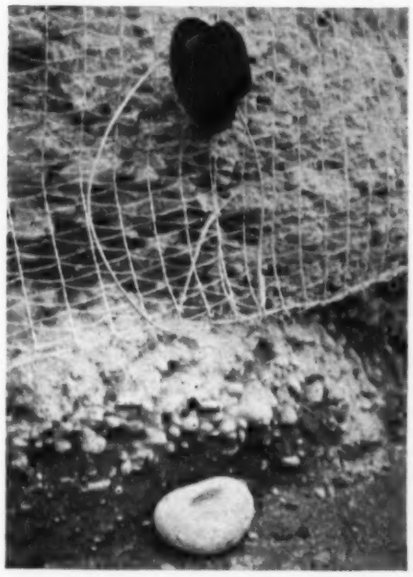
¶ V. L. Gill, Section Foreman, Mt. Hood highway, Oregon, just lining up his Marmon Herrington push

plow truck after an all night vigil of snow clearing on a road up the mountain to Timber Line Lodge. The four rotaries worked in the 18 ft. snow pack for several days on the 6 mile stretch. Gill says the rotaries should have a low speed of 100 ft. per hour to work properly and avoid clutch slipping.

¶ This large woven wire blanket is hanging on the cliff along the road out of Portland, Oregon, toward Troutdale. The close up view gives



you an idea of the size of the mesh. This curtain, which is hung by cables from the top of the cliff, has proved very effective in stopping loose rock



from crashing on the pavement. Separate strips are stitched together to form a curtain 200 ft. long and 150 ft. high. A ⅜ in. wire cable is stitched occasionally along the bottom edge and tied back loosely. It cost 37 ct. per square yard in place.

• •

¶ Note the notches cut in the lower auger of the rotary plow. This idea works fine for cutting up pavement ice crusts that form in way of plowing. For some work, the top auger also should be notched, according to

V. L. Gill, Section Foreman, Mt. Hood Highway, Oregon. Note also the hard metal (studite) welded on the periphery.

• •

¶ "The local members of the American Society of Civil Engineers enjoyed havinb Vic Brown attend their inner and get-together in Sacramento one Friday evening recently. However, they are all wondering what prevented his showing up at the inspection trip of the Shasta Dam the following days.—F. W. P. (California).

• •

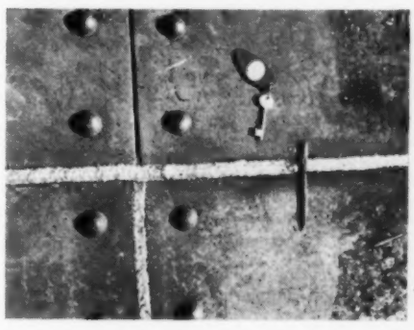
¶ Just got in from a day of inspecting tunnels dug under roadside slides, below the slip plane, to tap water through the roof and halt the slides. They were just out of Portland, Oregon. Oregon is using this idea as a last resort says Paul Van Scoy, engineer in charge. I should think so—they cost around $12.00 per foot to build, and they must be maintained. One slide alone has cost at least $30,000 and the end is not yet.

• •

¶ I can't leave Oregon without complimenting them upon their signing. It's good—all except for the mileage figures. Either paint them out, Sam, or better yet, make the mileage figures big enough to be read by fast traffic.

• •

¶ This is a view of the plates on the deck of an underpass just outside of the new federal airport, the Sacramento Air Depot, on which railroad ballast will be placed after a cushion of a bituminous mixture is



laid. The bridge inspector required the plates to be welded, even after riveting, to prevent leakage of water through the roof of the underpass. This is a good, neat job of electric welding. Two Lincoln electric welders furnished juice for the single op-

erator on the underpass. The Campbell Construction Company of Sacramento was doing the job.

• •

¶ View of excavation work on Shasta dam, California. Note the weaving construction roads built up the side of the mountain on which the 25-yd. White trucks haul the ma-

terial away from a 4½-yd. Bucyrus-Erie power shovel. I counted 12 trucks in the fleet; there may be more. Picture taken from east end seat looking west.

• •

¶ A. P. J. attended a meeting of the Sacramento (Calif.) Section of the Am. Soc. C. E. on March 17, 1939, at which Fred Panhorst, Bridge Engineer for the California Division of Highways, who is president, said: "This is the best meeting we ever had." Five minutes later I found out why—you should have seen that brunette in the red silk cowboy shirt. Fred had hired a group of cowboy singers (and Ferdinand girl singers, too) to liven the evening. I have a hunch Fred had a preview of the show.

• •

¶ As this is written we expect that Ira Taylor will be appointed state highway engineer of Kansas. A. B. Nuss just resigned. Ira was maintenance engineer back in 1937.

INTERESTING AUTOMOTIVE DATE

1894—S. H. Roper built a steam-driven car which attained a speed of 80 miles per hour and Elwood Haynes built a gasoline-driven car.

American Road

WASHINGTON, D. C.

ANNUAL ARBA MAY MEETING AND GOLF

Down the Road

By CHARLES M. UPHAM

Engineer-Director,

American Road Builders' Association, Washington, D. C.

ROAD BUILDING CURES UNEMPLOYMENT

A few years ago the word "boondoggling" became a part of the vocabulary of almost every American. To "boondoggle" was to create employment by the invention of work projects of as little real utility as the boondoggling or braid on an officer's uniform.

Today, however, we are beginning to take a more realistic view of the situation. Unemployment is still the nation's Number I economic problem and it is now apparent that it cannot be solved by hiring one crew of men to carry leaves from one side of a street to the other and another crew to transport them back again. Water poured down a rathole is of little use in priming a pump. Money spent on make-work schemes provides, at best, only a temporary amelioration of our difficulties.

It is, therefore, essential that we find some solution to the problem which will continue to provide employment long after the federal government has ceased pouring money from the national treasury into public projects.

The ideal solution should give the general public its full money's worth for every dollar expended to end unemployment. As a cure for our unemployment problem, as well as a solution to this country's other major economic ills, a program of increased highway construction fully meets both requirements.

The name boondoggling will never be applied to road building. Every penny expended for the improvement of our highway system brings a hundredfold return in social, economic and cultural benefits to all our citizens. A few years ago Germany started the construction of a super-highway system to help cure its economic ills. When the full benefits of such a program were realized, it was decided that the public funds of Germany should be invested in highways, not only for the purpose of gaining the numerous benefits that result from the construction of better roads, but mainly as an important step in working out its unemployment problem. Germany had a gigantic unemployment list and, although only 400,000 men were utilized for highway construction, the nation's unemployment was reduced to a minimum soon after its road program was started.

The explanation is simple. If a thousand men are utilized to build a highway, long before the highway is completed, filling stations will open up along its route, augmented by garages, supply houses, salesrooms, service stations, etc. Restaurants and hotels will be constructed. Houses, too, will be built and the building of schools and other civic structures will soon follow. A little later, farms will be cultivated and the farmers will transport their produce to market on newly purchased trucks. Bus routes will be established and the growth of entire communities will be encouraged. The result is all too evident. In addition to the thousand men originally employed to construct the road, demands for additional labor have been stimulated and the incentive for outside agencies to invest additional funds has been provided. The employment of a thousand men to build a road eventually brings about the creation of jobs for many additional thousands of our unemployed!

This was undoubedtly the principal in effect when millions of men were put to work as a result of Germany's super-highway program. With America's superior resources, we will harvest even greater success from a similar program. At its completion, we will not have merely a temporary surcease from our economic disabilities. We will have provided for the permanent employment of millions in the new industries and enterprises that are always the outgrowth of highway construction. We will have provided peace-loving America with a national system of highways to serve its traveling citizenry with increased safety, comfort and convenience in peacetime pursuits.

ANNUAL ARBA MAY MEETING AND GOLF TOURNEY IN WASHINGTON, MAY 24-25

The American Road Builders' Association has set May 24 and 25 as the dates for its annual May business meeting at the Willard hotel in Washington, D. C. The directors of the various ARBA divisions will meet to discuss their special problems. The Highway Contractors' Division will meet with the officers of the affiliated state groups and

Road Builders Golf Trophy

a joint luncheon-meeting of the boards of directors of the ARBA and the Manufacturers' Division is also scheduled. The annual meeting of the ARBA and all its divisions will follow a buffet supper on the evening of the 24th.

George F. Schlesinger, recently elected ARBA treasurer, is serving as chairman of the committee in charge of the annual golf tournament to be staged at Washington's Congressional Country Club on the opening day of the meeting. The name of the holder of low-net score will be inscribed on the permanent Road Builders' Golf Trophy on display in the ARBA offices in the National Press Building. He will also receive a duplicate of the cup, suitably engraved. Other prizes are being donated by ARBA manufacturer members.

WHITMAN NEW CHAIRMAN OF MARYLAND ROAD COMMISSION

Ezra B. Whitman, well known Baltimore engineer, was last month appointed to the chairmanship of the Maryland State Highway Commission.

Builders' Review

MAY, 1939

In the production of each 1,000,000 automobiles, it is estimated that the agricultural products from a half-million acres of land are used.

TOURNEY IN WASHINGTON, MAY 24-25

With Our State Groups

COLORADO

More than $3,000,000 worth of highway construction was put under contract by the Colorado State Highway Department in April. The highway program had been held up since early January because of wage disputes. These were settled on March 28, following a ten-day hearing by the Colorado State Industrial Commission, when the commission announced its ruling reaffirming the wage scales paid on highway work by the state during the past two and a half years. State Highway Engineer Charles D. Vail was assisted in his defense against the claims of union labor by the Colorado Association of Highway Contractors, state affiliate of the ARBA. The 1939 Colorado highway program involves approximately $9,000,000.

FLORIDA

Members of the executive committee of the Florida Section, ARBA, recently appointed by Chairman S. B. Brinson, are L. B. McLeod of Orlando, chairman John E. Ballenger of Lakeland, J. D. Manly of Leesburg, J. L. Cone of Tampa, Alex Brest of Jacksonville, Charles W. Smith of Pensacola, D. A. Cleary of West Palm Beach and George D. Auchter of Jacksonville. Florida Section Vice-Chairman J. E. Dodson of Miami will also serve on this committee.

ILLINOIS

The Illinois Road Builders' Association, ARBA affiliate, has just published a complete an authoritative guide to highway construction in Illinois. This "Contractors' Handbook and Legislative Directory" contains the names and addresses of state and national representatives from Illinois, a brief synopsis of the specifications covering road construction, a roster of the personnel of each highway district accompanied by a highway district map and names, addresses and telephone numbers of all contracting firms and allied businesses in Illinois. Members of the IRBA appear in bold-face type.

MICHIGAN

The annual meeting of the Michigan Road Builders' Association, an ARBA affiliate, was held at the Hotel Statler, Detroit, on April 20. Principal speakers at the banquet-meeting included Charles M. Upham, ARBA engineer-director, who gave an illustrated lecture on Germany's super-highways, and United States Congressman Jesse P. Wolcott of Michigan. Other speakers at the conclave were ARBA President and Michigan State Highway Commissioner Murray D. Van Wagoner, Michigan Secretary of State Harry F. Kelley, United States Senator Prentiss M. Brown, Mayor Reading of Detroit and William C. Slee, assistant engineer-director of the ARBA. Secretary C. W. Otto of Lansing Chamber of Commerce acted as banquet toastmaster and MRBA President Julius Porath presided at the afternoon business meeting.

NEW HAMPSHIRE

Francis B. Kenney, city surveyor of Manchester, N. H., was elected president of the New Hampshire Good Roads Association at the group's annual meeting in March. Other newly elected officers of the ARBA affiliate include LeRoy F. Johnson, maintenance engineer of the state highway department, vice-president, and George Fedor and Fred Gardner of Concord, directors. David L. Fosburgh, Concord, was re-elected to the secretaryship.

PENNSYLVANIA

The Associated Pennsylvania Constructors, a ARBA affiliate, held its annual spring meeting at the Hershey hotel in Harrisburg on May 4. Federal and state legislation concerning the motor fund and other phases of the highway construction program were discussed. The application of the federal Fair Labor Standards Act to the construction industry was also given careful consideration.

TENNESSEE

Officers elected at the recent annual meeting of the Tennessee Road Builders' Association, ARBA affiliate, include S. B. Ziegler, president; Thomas Johnson of Jackson; R. E. Martin of Nashville, and Marvin Leventhal of Chattanooga, vice-presidents; J. S. Dunbar of Nashville, treasurer, and B. G. Young of Jonesboro and Mike Wesner of Nashville, directors at large. T. M. Strider, retiring president, was given a vote of thanks and George R. Dempster, engineer-manager, received a vote of confidence for his program for 1939. A renewed fight against the diversion of highway funds to non-highway purposes is scheduled to get under way immediately.

John A. Long

ARBA COUNTY DIVISION HEADED BY JOHN A. LONG

An expanded program of activity will be undertaken by the County Officials' Division of the American Road Builders' Association during the remainder of the year. John A. Long, former engineer of Duval County, Jacksonville, Fla., has been placed in charge of this division and has established headquarters in the ARBA Washington, D. C., offices. The new engineer-manager of the County Division will have full responsibility for the policies and management of his branch of the ARBA. The office will serve as a clearing house and advisory service for the 3,000 counties in the country.

Mr. Long recently completed his fifth year as Duval County engineer. He had previously served as highway engineer for two Mississippi counties, as engineer of Lee County, Fla., and with the Mississippi and Florida highway departments. He is a past president of the Florida Section, American Society of Civil Engineers.

Bureau Engineers Supervising Construction of a Road in Glacier National Park. The Bureau Supervises the Construction of Main Roads in National Parks and National Forests.

THE UNITED STATES BUREAU OF PUBLIC ROADS

By D. M. BEACH
Associate Highway Engineer, Bureau of Public Roads

TWENTY-SEVEN years of road building, preceded by 19 years of teaching others how to build roads, briefly describes the history of the United States Bureau of Public Roads. Created in 1893 as the Office of Road Inquiry, the 46 years of the Bureau's existence span the period during which the pendulum of public interest in road construction has swung from apathy to enthusiasm.

U. S. Office of Road Inquiry

Establishment of the Office of Road Inquiry came at a time when public interest in better roads was just beginning to be aroused after a long coma induced by the railroad. The processes of road building had undergone practically no change during the decades following the disappearance of most of the turnpike companies. Long distance travel was almost entirely by rail, and roads were thought of only as the means of reaching the nearest railroad station or village. The existing roads were poorly constructed and inadequately maintained, as judged by present-day standards. County and township authorities administered the roads, with limited amounts of funds available from property taxation.

The organization of the League of American Wheelmen in 1880 has been called the turning point marking the beginning of the modern period of highway improvement. One of the principal objects of the League was to secure better roads, and it worked energetically to achieve its purpose. To the efforts of the League can be credited the first practical steps taken to obtain better roads—the passage of State-aid laws in New Jersey in 1891 and in Massachusetts in 1892. The next fruit of the wheelmen's efforts is found in the establishment of the U. S. Office of Road Inquiry in accordance with an Act of Congress approved March 3, 1893.

The purpose of the office as defined in the statute was to make inquiries in regard to systems of road management throughout the United States; to make investigations in regard to the best methods of road making; to prepare publications on this subject; and to assist agricultural colleges and experiment stations in disseminating information on the subject. The initial appropriation for this purpose was $10,000.

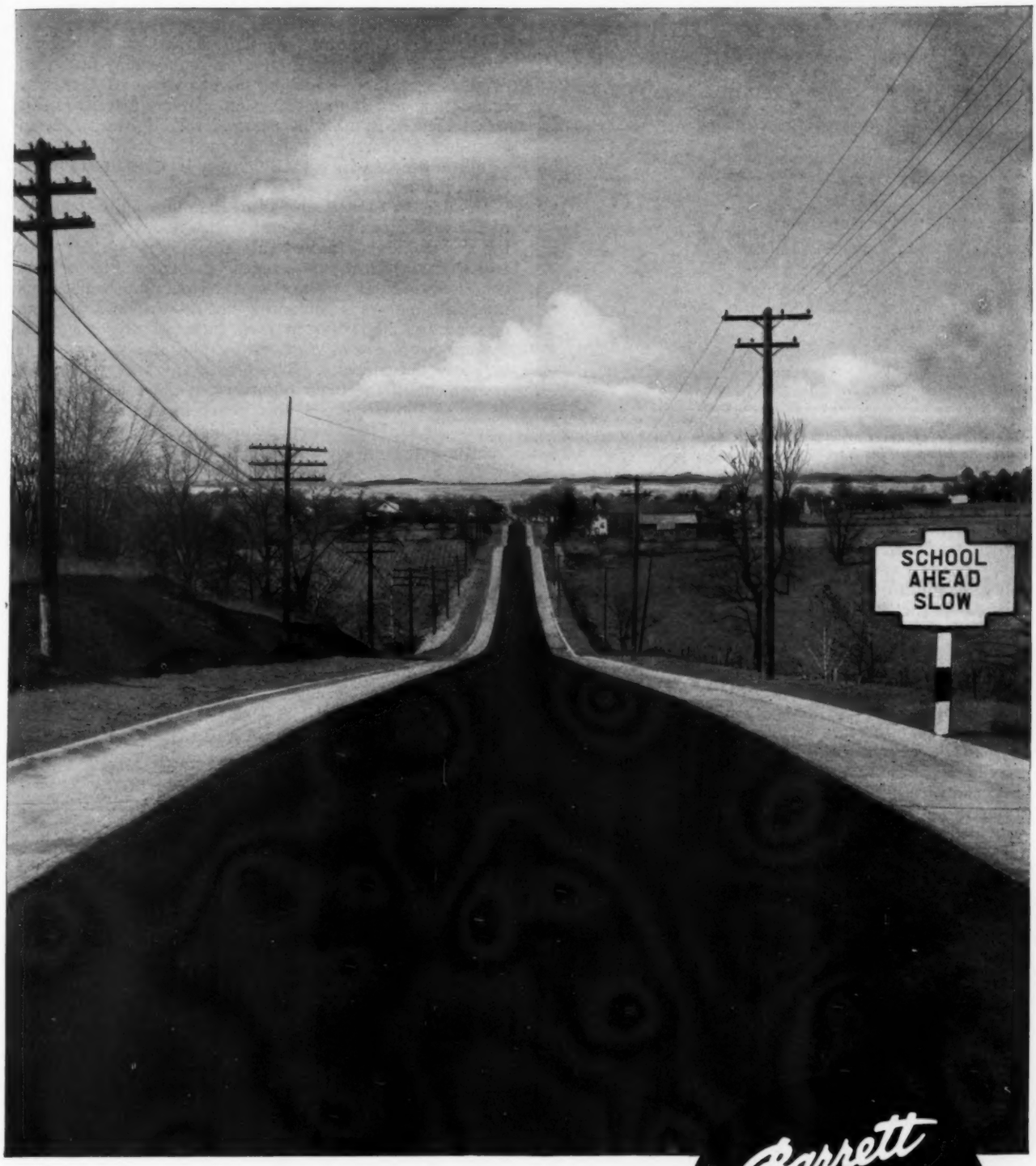
The Federal office carried its message directly to the local officials in charge of building roads, and, by actual demonstration on short sections of object-lesson road in every State, taught them the methods of road construction which its studies showed to be best. Through bulletins, lectures, and good roads trains it carried its message to the public, and there is no doubt that creation of several of the early State highway departments can be credited to its work.

While it was investigating and studying and teaching others how to build good roads, it was also preparing itself for the opportunity which came to it at first in a small way in 1912 to assume the direct responsibility for the construction of roads paid for in part by the Federal Government.

The First Federal Aid for Road Construction

The Bureau was launched upon its new career of responsible road building by an act that provided $500,000 for expenditure by the Secretary of Agriculture in cooperation with the Postmaster General for the improvement of post roads selected by them. The work was undertaken in cooperation with local units, which were required by the terms of the act to supply local funds in amounts at least double the Federal funds.

The work thus financed was on projects in 29 counties in 13 States, and the program resulted in the construc-



. . . and the road-builder has done his share by providing "TRACTIONIZED" SKID-SAFE TARVIA PAVEMENT . . .

Barrett Tarvia
GOOD ROADS AT LOW COST

THE BARRETT COMPANY New York Chicago Birmingham St. Louis Detroit Philadelphia Boston Providence Lebanon Rochester Baltimore Minneapolis Cleveland Columbus Toledo Youngstown Syracuse Hartford Buffalo Cincinnati Bethlehem Portland, Me. Norwood, N. Y. In Canada: THE BARRETT COMPANY, LTD. Montreal Toronto Winnipeg Vancouver

AMERICA'S LEADING MANUFACTURER OF COAL-TAR PRODUCTS • ROOFINGS • TARVIA • CHEMICALS

One Corner of the Bureau's Research Laboratory at Arlington, Va. The Bureau Has Conducted Research on Road Materials for Many Years.

tion of some 426 miles of road at a total cost of about $1,800,000. This initial experience in the actual construction of roads was of great value to the Bureau when, in 1916, the Federal-aid Road Act gave it the responsibility of administering a larger program in cooperation with all of the States.

This legislation broadened and greatly enlarged Federal participation in road construction, establishing as a policy what in the 1912 act had been more or less of an experiment—Federal aid to the States for road construction. The act appropriated $75,000,000 to be expended over a period of 5 years for the improvement in all States of roads "over which the United States mails now are or may hereafter be transported . . ."

Certain features of the act effected changes in road administration of far greater importance than the funds it provided. The most important of these was a requirement that, to share in the funds, each State must first establish a State highway department adequate in the opinion of the Secretary of Agriculture to cooperate with him in the work. As a result of this requirement the principle of State control of main highways, long advocated by the Bureau, was finally adopted by all States.

The formula for distributing the funds among the states has, by the test of time, proved equitable, in that it is still used in practically its original form for apportioning Federal-aid funds for roads. The formula requires that the funds be divided among the 48 states one-third in proportion to population, one-third in proportion to area, and one-third in proportion to mileage of rural post roads. The only change, which slightly increases the share for 4 states, is a provision that no state shall receive less than one-half of 1 per cent of the funds apportioned for any year.

The act limited the amount payable by the government to 50 per cent of the cost of construction. Subsequent legislation has increased the Federal share in certain public lands states, to be discussed later. An original provision limiting the amount of Federal funds that could be spent per mile of road was later revised and then removed altogether.

The initiative in selecting projects for improvement was given to the states, but the projects selected were made subject to approval by the Secretary of Agriculture. The states were given the responsibility of adequately maintaining roads on which the Federal funds had been spent.

Federal Aid Highway Systems Formed

The act had one serious shortcoming. The Federal funds could be and were spent on such widely dispersed projects that there could be no guarantee of the early completion of a connected system of main arteries. This was remedied in 1921 by the Federal Highway Act, an amendment of the original act and in itself the most significant piece of Federal highway legislation in United States history.

In addition to retaining all of the outstanding features of the earlier act, the Federal Highway Act provided for the designation of a Federal-aid highway system upon which the Federal funds must be spent. This system consisted originally of a network of main intercounty and interstate highways containing not more than 7 per cent of the rural highways in each state, jointly designated by the Secretary of Agriculture and the various state highway departments. The present high degree of improvement of the main highways in the country is evidence of the wisdom of this Federal policy.

The Federal funds were available for expenditure only on rural portions of the system, and could not be used to pay costs of right-of-way or property damages. By later amendment municipal extensions of the 7 per cent system have been made eligible for improvement with Federal-aid funds.

The proportion payable by the Federal government in states where more than 5 per cent of the area is Federally owned public land has been increased above 50 per cent by an amount equal to one-half the percentage of unappropriated public land in the state. Fourteen western states are affected by this provision, the states and corresponding percentages payable with Federal funds being as follows: Nevada, 86.01; Utah, 74.38; Arizona, 72.12; Wyoming, 63.13; New Mexico, 62.41; Idaho, 61.12; Oregon, 60.46; California, 58.51; Montana, 56.72; Colorado, 56.36; South Dakota, 55.07; North Dakota, 53.60; Oklahoma, 53.22; and Washington, 52.54.

Other amendments to the basic legislation have made Hawaii, Puerto Rico, and the District of Columbia eligible to share in the Federal funds. States that have improved 90 per cent of their Federal-aid highway systems may increase the mileage of the designated system. States that use highway-user revenues for nonhighway purposes may be penalized an amount not exceeding one-third of their highway apportionments.

Large Emergency Funds Become Available

The bureau's chief activity continued to be administering Federal-aid funds for rural highways until 1933, when large emergency funds were appropriated by Congress to provide employment. The National Industrial Recovery Act, approved June 16, 1933, appropriated $400,000,000 to be expended on both rural and urban portions of the Federal-aid highway system, and on secondary or feeder roads. Because the primary objective of the Act was to provide employment on useful public work, special regulations designed to result in the maximum of employment were drafted for the projects financed with these funds, and even the apportionment formula was slightly altered to give greater weight to the population factor. These funds, and subsequent funds totaling $400,000,000 for highways and $200,000,000 for grade crossings, were provided as outright grants to the states, requiring no matching state funds.

During the fiscal years 1934 and 1935 no regular Federal-aid funds were provided because of the large emergency funds then available. Thus, the continuous succession of annual Federal-aid authorizations was interrupted for the first time since its inception in 1916. Regular Federal-aid authorizations were made for 1936 and

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1937 with an amendment permitting improvement of urban extensions of the Federal-aid system.

Beginning Broadened Federal-Aid Program

The fiscal year 1938 marked the beginning of a broadened Federal-aid program. In the broadened program three specific funds were provided as follows: For improvements on rural and urban portions of the Federal-aid system; for secondary or farm-to-market roads; and for the elimination of hazards to life at railroad grade crossings. The funds for highways and secondary roads were apportioned among the states in accordance with the original formula. Grade crossing funds were apportioned according to the following formula: One-half in proportion to population; one-fourth in proportion to railroad mileage; and one-fourth in proportion to the mileage of the Federal-aid system.

The highway and secondary road funds were required to be matched by the states, the grade crossing funds were grants to the states, available without matching. Use of the grade crossing funds, both in the emergency program and in the regular program, has not been restricted to any highway system, the only requirement being that they be spent to eliminate or protect the most dangerous crossings.

The states are required to select important roads, not on the Federal-aid system, for inclusion in a system of secondary roads on which the Federal funds for secondary roads must be spent. Selection of this system, to comprise not more than 10 per cent of the rural roads in each state, is required to be based upon factual surveys in each state for the planning of a complete highway system.

Certain features of the earlier highway legislation that have been continued and made applicable to the secondary and grade crossing work include: Initiation of projects by states; adequate maintenance by states at their expense; costs of right-of-way and property damages paid wholly with state or local funds.

The significance of the latter feature can be more fully understood when it is pointed out that on many recent projects in large cities right-of-way and property-damage costs have approximately equalled the actual construction costs.

A special agent and engineer and a small clerical force were the complete staff on the Bureau of Public Roads in 1893, when it was created as the Office of Road Inquiry. The organization gradually grew in size but was still small when the Federal-aid Road Act was passed in 1916. This act greatly expanded the bureau's functions, and, correspondingly, it was necessary to expand the organization properly to discharge its new duties.

Beginning with $5,000,000 for the fiscal year 1917, Federal-aid authorizations increased to $100,000,000 in 1921, dropped to $50,000,000 in 1923, and then increased to $200,000,000 for 1938 and 1939. Funds for 1940 and 1941 have been authorized, being $135,000,000 and $160,000,000 respectively.

The Federal funds are available for one year following the close of the fiscal year for which authorized. In only two instances have Federal funds been lost through failure to obligate them within the prescribed time. Funds so lost are required to be reapportioned among all states.

The Federal law provides that up to 2½ per cent of the funds authorized shall be available to pay the expenses of engineering, administration, and research of the Bureau of Public Roads.

Other Classes of Road Construction Supervised by Bureau

In addition to administering the Federal-aid and emergency funds in cooperation with the various state highway departments, the bureau supervises several other classes of road construction. Most important of these are the construction of highways in National Forests, National Parks, and public lands.

Engineers at Washington Headquarters Reviewing Plans for Federal-Aid Projects.

Funds for road and trail construction in the National Forests have also been provided along with the Federal-aid and emergency funds. The major work with these funds is supervised by the Bureau of Public Roads. Construction of minor roads and trails is supervised by the Forest Service. Funds for this work have been authorized in the amount of $10,000,000 for the fiscal year 1940.

Under an agreement with the National Park Service, the Bureau of Public Roads has for a number of years supervised the construction of roads in and leading to National Parks and monuments. Funds have been authorized for the fiscal year 1940 in the amounts of $4,000,000 for National Park roads and $6,000,000 for parkways.

Beginning in 1931, specific funds have been authorized for the survey, construction, reconstruction and maintenance of roads through public lands. One million dollars is the amount authorized for such work for the fiscal year 1940.

Certain Federal funds for the repair and reconstruction of flood-damaged roads and bridges on the Federal-aid highway system have also been administered by the Bureau of Public Roads.

The bureau has also been called upon to administer other classes of road work during recent years. Most important of these are loan-and-grant highway projects, the detailed administration of which was transferred to the bureau in 1934 by the Public Works Administration. Included also are work relief highway projects, which were begun in 1933 to relieve distress in particular areas stricken by drought and flood; and cooperation with the Central American countries in surveying and constructing the proposed Inter-American highway from Panama to the United States.

Research Important Function of Bureau

Research in the methods and materials of highway construction is necessarily an important function of the bureau, both to solve the various technical problems constantly arising in construction work and to extend the frontiers of highway engineeirng science. The bureau's program of highway research, the most extensive of its

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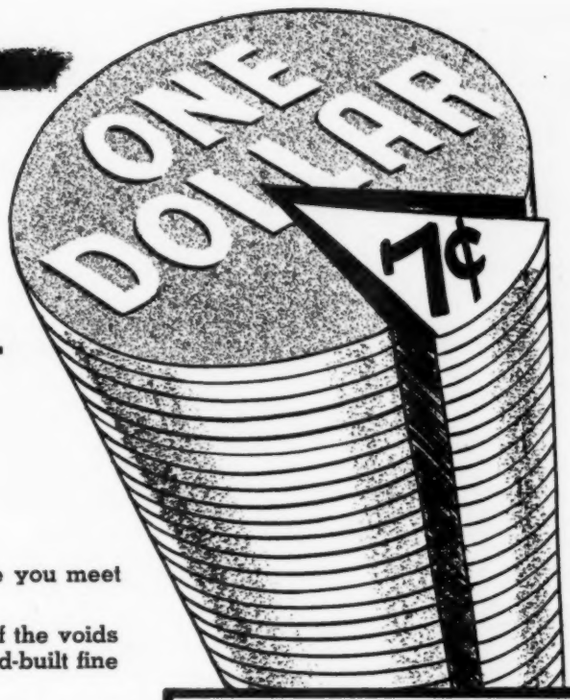

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Characteristics of Traffic Are Determined in the State-Wide Highway Planning Surveys Being Conducted by 46 States in Cooperation with the Bureau.

kind under any single agency, is carried on independently and in cooperation with the state highway departments and with other agencies.

Dissemination of information on the best methods of road building was one of the first duties of the bureau, and the bureau has always endeavored to disseminate promptly the results of its studies. Its monthly research periodical *Public Roads* circulates throughout the world as one of the most authoritative publications in its field. The bureau's library contains the most extensive collection of highway engineering literature in the country, and is available to all persons desiring to use its facilities for study. Film strips, motion pictures, and exhibits are other of the means used to carry its educational message to the public.

The Bureau Organization

The headquarter's organization of the bureau is located in Washington, D. C., headed by the Chief of Bureau. Staff divisions of design, construction, and control, each headed by a division chief, advise and assist the Chief of Bureau in the adminstration of Federal highway work.

Through 13 district offices, each headed by a district engineer, the bureau maintains direct contact with the state highway departments. The bureau also maintains in most of the states, as a part of the district organization and as a still more direct contact with the highway departments, a state office that operates in close cooperation with the highway department.

The district offices are as follows:

District 1, with headquarters in Portland, Oregon, supervises work in Oregon, Washington, and Montana.

District 2, with headquarters in San Francisco, California, supervises work in California, Arizona, and Nevada.

District 3, with headquarters in Denver, Colorado, supervises work in Colorado, New Mexico, and Wyoming.

District 4, with headquarters in St. Paul, Minnesota, supervises work in Minnesota, North Dakota, South Dakota, and Wisconsin.

District 5, with headquarters in Omaha, Nebraska, supervises work in Nebraska, Iowa, Kansas, and Missouri.

District 6, with headquarters in Fort Worth, Texas, supervises work in Texas, Arkansas, Louisiana, and Oklahoma.

District 7, with headquarters in Chicago, Illinois, supervises work in Illinois, Indiana, Kentucky, and Michigan.

District 8, with headquarters in Montgomery, Alabama, supervises work in Alabama, Florida, Georgia, Mississippi, and Tennessee.

District 9, with headquarters in Albany, New York, supervises work in New York, Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, Rhode Island, and Vermont.

District 10, with headquarters in Washington, D. C., supervises work in the District of Columbia, Delaware, Maryland, Ohio, and Pennsylvania.

District 11, with headquarters in Juneau, Alaska, supervises forest road work in Alaska.

District 12, with headquarters in Ogden, Utah, supervises work in Utah and Idaho.

District 14, with headquarters in Spartanburg, South Carolina, supervises work in South Carolina, North Carolina, Virginia, and West Virginia.

Offices are also maintained in Honolulu, Hawaii, and San Juan, Puerto Rico, for administering work in those possessions of the United States.

A regional headquarters for the administration of Federal-aid and emergency road construction and forest and park work in the west is maintained in San Francisco. This office is under the direction of a deputy chief engineer, through whom the district engineers of districts 1, 2, 3, 11, 12 and Hawaii report.

National park and forest work in all states east of the Rocky Mountains is under the supervision of a district engineer who heads the Division of National Parks, east and south. This division, with headquarters in Washington, D. C., supervises the planning of forest highway systems, makes reconnaissance surveys for the planning and construction of parkways, and does other special highway work of location, design, and construction.

Two staff divisions in Washington conduct the research work of the bureau. The Division of Tests deals with the physical problems involved in the selection of road materials, and the forces of traffic and climate that affect road structure and design. The Division of Highway Transport makes studies of the economics of highway transport and the characteristics of traffic.

The Division of Control keeps the necessary control accounts showing the status of all funds administered by the bureau, keeps complete records on all active and past work, collects data regarding highway finances and mileage and motor vehicle registration, and is responsible for the purchase of equipment and supplies. Up-to-date figures are kept showing the amounts of Federal road funds paid to each state and the amounts remaining available to each state.

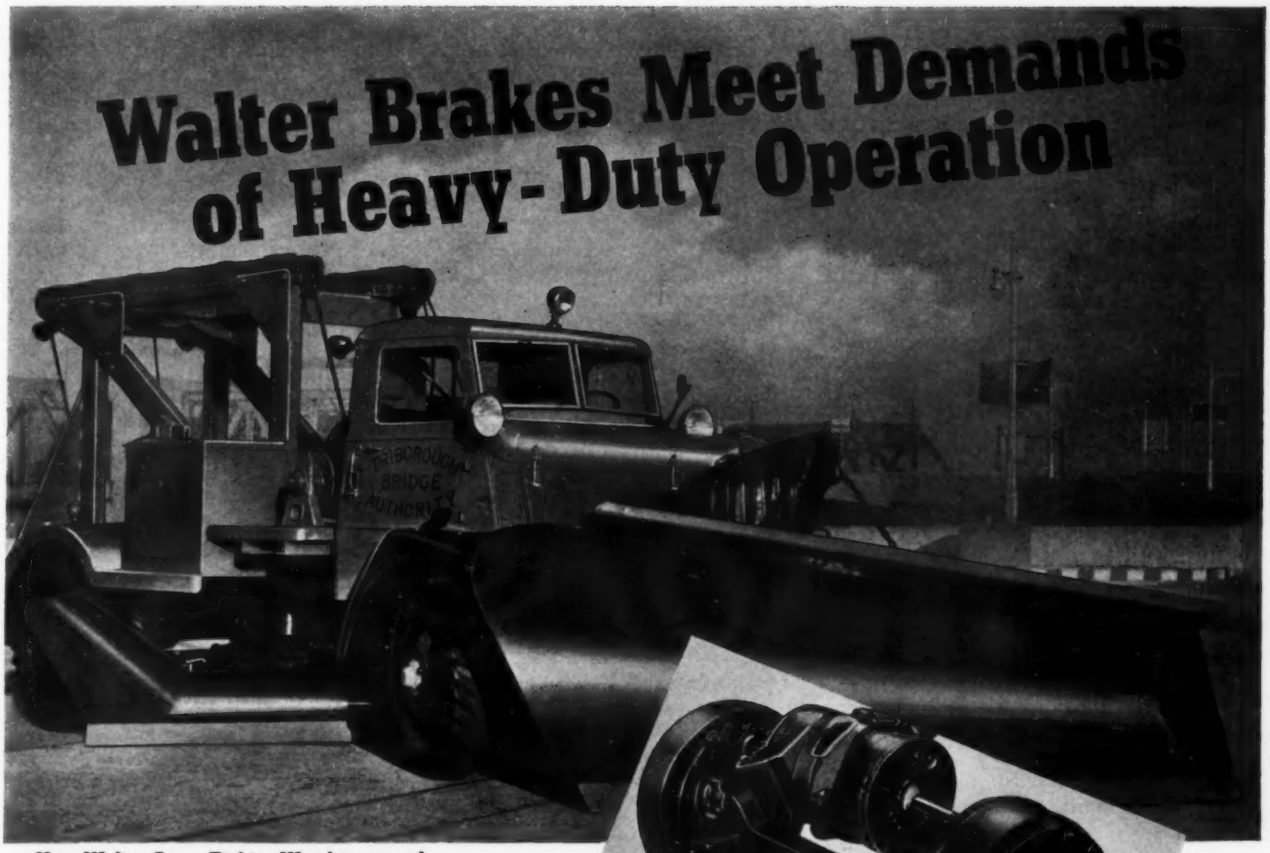
The Division of Highway Laws and Contracts, in addition to its advisory functions in connection with administration of bureau activities, handles details of preparation and execution of contracts and of related matters pertaining to Federal-aid, emergency, and forest road construction, and also makes studies and gives advice concerning state and Federal highway legislation.

Through the Division of Information information is given to the public in various ways—through correspondence, bulletins, exhibits, motion pictures, film strips, and other means. This division also has charge of editing and publishing the bureau's magazine *Public Roads*.

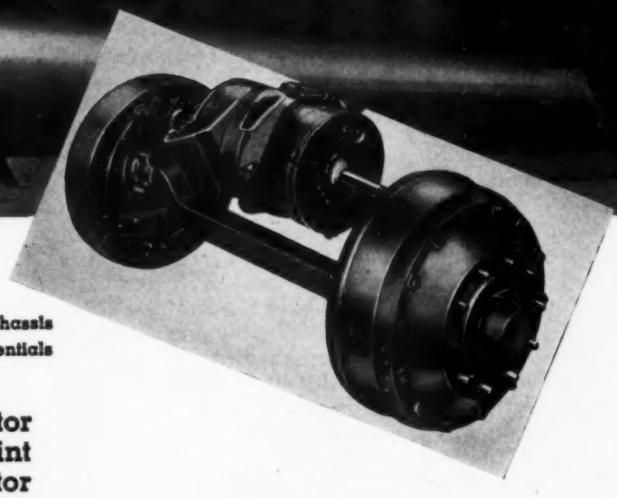
The Apportionment of Federal Funds

Because the Federal fiscal year begins July 1, several months after the highway construction season has begun, the Federal funds are apportioned by the Secretary of Agriculture at least 6 months before the beginning of the fiscal year for which authorized. This gives the states time in which to obtain Federal approval of programs and of the detailed plans and specifications and to advertise and award contracts, so that the actual construction work will not be delayed. Particularly in the northern states is this important, as there the construction season is relatively short for certain types of work.

Walter Brakes Meet Demands of Heavy-Duty Operation



New Walter Snow Fighter Wrecker owned by Tri-Borough Bridge Authority, New York



Walter Brakes are mounted in the chassis at each side of front and rear differentials

Walter Brakes are an important factor in the efficiency of Walter Four-Point Positive Drive Snow Fighters and Tractor Trucks. Four internal shoe brakes are mounted in the chassis — one at each side of front and rear differentials — protected from mud, snow and ice. Braking action is applied to each wheel through its drive shaft. As Walter drive is designed to exert the enormous tractive effort of which these powerful trucks are capable in the lower gears, it is ample to withstand all stresses from brake application.

Walter Brakes have unusually long lining life because they operate at lower unit pressures on lining surfaces and because of more rapid cooling with higher peripheral speed. Brake shoes are mounted on a brake mounting plate connected to a cross shaft to the brake on the opposite side. Approximately even brake adjustment insures equal brake action. Vacuum booster application gives effective braking with minimum effort. Where additional brake capacity is required another pair of heavy duty shoe brakes at rear wheel hubs are provided and these are operated by Westinghouse air pressure.

Walter Brakes meet all legal requirements of the various states.

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Beginning with the fiscal year 1923, a change was made in Federal-aid procedure that has proven confusing to the public mind. Prior to that time Federal-aid legislation made direct appropriations of funds. Since Federal-aid funds are only paid to the states for completed work, the appropriated funds lay idle in the treasury for some time before they were actually paid to the states. Funds for 1923 and subsequent years were merely authorized to be appropriated. The states went ahead and planned their road work as before, and, as money was needed to make payments for completed work, Congress would appropriate funds. Although sound from a budgetary standpoint and good business procedure, this practice has led to the mistaken belief that the appropriated funds are additional to those previously authorized.

Project Construction Programs Submitted to Bureau

After apportionment of funds by the Secretary of Agriculture, the states submit programs of projects for construction. The programs are reviewed in the bureau's district offices and, upon approval, are referred to the headquarters office for consideration and final approval by the Chief of Bureau.

Programs received in Washington are referred to the Division of Design, which determines if the projects included are eligible for improvement under the limitations specified by the authorizing act, and if the projects are of greatest priority. If critical review shows the programs to be satisfactory, the states are notified so that they can proceed with the submission of project statements and detailed plans, specifications, and estimates for each project.

Each year the Division of Design reviews several thousands of sets of plans for highway work to cost hundreds of millions of dollars. Since the states have been cooperating with the bureau in building Federal-aid roads for the past 23 years and are thoroughly familiar with the bureau's requirements, a large majority of the projects submitted are approved without change. A small percentage of the plans are approved with suggestions for improvements by changes in design for specifications.

In a country as large and diverse in its physical and economic conditions as the United States, it is not practicable to adopt standards of road construction applicable in every section. For this reason the bureau has not promulgated absolute standards of design and construction for all states. Instead, it has endeavored, by agreement with the individual state highway departments, to establish for each state standards compatible with the highway needs and available resources of the state.

Standards of Design and Construction Raised

Examination of plans prepared in all states for various types of roads and bridges enables the bureau to perceive points of excellence and weakness in the practice of each state. The bureau thus serves as a clearing house for the interchange of ideas between all of the agencies with which it cooperates. The gradual raising of the standards of design and construction that has resulted is one of the greatest benefits of the cooperative relationship established by the Federal-aid policy.

After plans, specifications, and estimates have been recommended for approval by the bureau's district engineer, the state may proceed with the advertising for bids and awarding of contract. Upon approval of the project in Washington, the district engineer concurs in the awarding of the contract if he finds that the regulations governing this procedure have been complied with.

Concurrence in awards is given in advance of the final approval of the plans, specifications, and estimates, to facilitate construction. The Federal government is not definitely committed to participation in the cost of any project, however, until the plans, specifications, and estimtaes have been approved in Washington, and until a formal agreement between the state and the Federal government covering participation has been executed.

Specifications, designs, and estimates for bridges and structures are reviewed by the bridge section of the Division of Design. This section also does other work involving bridge design and construction.

After the bureau has concurred in the award of a contract, the state proceeds with the execution of the work. A copy of the contract together with related documents are forwarded to the Washingon office where they are reviewed by the Division of Construction. This review is made to insure that the documents are in full compliance with Federal laws and regulations.

Nearly all of the cooperative work between the bureau and the states is done by contract, although a state may use the force account method when conditions warrant it. Such work is handled by the bureau in the same way as contract work.

Periodic Inspections by Bureau Engineers

All construction work is supervised and inspected by engineers of the state highway department. Periodic inspections are made by bureau engineers, and at least once a month reports are submitted to Washington for review by the Division of Construction. If the reports indicate faulty construction or inferior materials, the district engineer notifies the state at once and further Federal payments are suspended until the faulty conditions are rectified or satisfactory materials are supplied.

After a project has been completed a final voucher is submitted by the state. This is passed to the Division of Construction for engineering review and is then passed to the Division of Control for audit and payment.

The Federal government still continues its interest after construction of a road or structure has been completed and the Federal share paid to the state. The Federal law requires that the states shall maintain the roads and structures entirely at their expense. At least once each year all completed work is inspected by bureau engineers, and that the penalty for improper maintenance has never been imposed is a tribute to the general excellence of state maintenance standards. Field reports to the Division of Construction on state maintenance operations enable it to act as a clearing house on new methods and improved practices.

The Highway Planning Surveys

The bureau and the highway departments of 46 states are now engaged in highway planning surveys, the findings of which will have a profound influence on future highway policies. The Hayden-Cartwright Act of 1934 and subsequent Federal highway legislation have authorized the use of Federal funds for conducting highway planning surveys, whose purpose is to collect all pertinent facts needed on which to base programs for future highway improvement. Undertaken in accordance with an outline of study developed by the bureau and the states, the surveys consist of: (1) A complete inventory of all existing roads; (2) a survey of traffic using the roads; and (3) a financial and road use study. Facts revealed by these studies will enable each state to make the most equitable allocation of funds for road construction and maintenance.

The surveys will be an invaluable aid to the bureau and the states in attaining their common objective of providing the safest and best highways possible with the funds available.

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MAN MOVES MOUNTAIN WHEN MOUNTAIN IS IN WAY

Hydraulic Giants Periodically Persistently Gouging On Country's Most Unusual Highway Grading Job

By VICTOR J. BROWN
Publishing Director,
ROADS AND STREETS.

WHAT is probably the most unusual highway grading job in the United States is nearing completion in Trinity County, California, on relocated U. S. 299 about 2 miles west of Weaverville. Giant hydraulic monitors are gouging away a mountain saddle to a depth of 230 ft. For 6 years the 8-in. and 9-in. nozzle giants have been periodically hydraulicking a 10,000,000 cu. yd. cut. The whole operation of squirting 2 tons of water a second into the side of the mountain is contained within a distance of 1 mile, with 80 per cent of the volume of work within a half mile of length. The project was the dream of Mr. F. W. Haselwood, district engineer for the Redding District of the California Division of Highway. He patiently promoted the idea in the face of lack of support from higher authority until the project was approved and started. Finally, in 1934, the state highway commission allotted the first $100,000 of a required $250,000 for the job and it was started.

The reasons for lack of support by the state highway engineers is perfectly logical to experienced highway engineers. The location of the road is certainly not economical from the point of view of cost to traffic; but the state highway commission voted it into the state highway system on April 29, 1932, and it is from this point on that concerns the engineer. A more economical water level route was available, barring possible injunction proceedings and political understandings. Since the highway was officially adopted to be constructed in the vicinity of its present location, it was the highway engineer's task to get the best relocation possible for the new, improved route. As stated, a

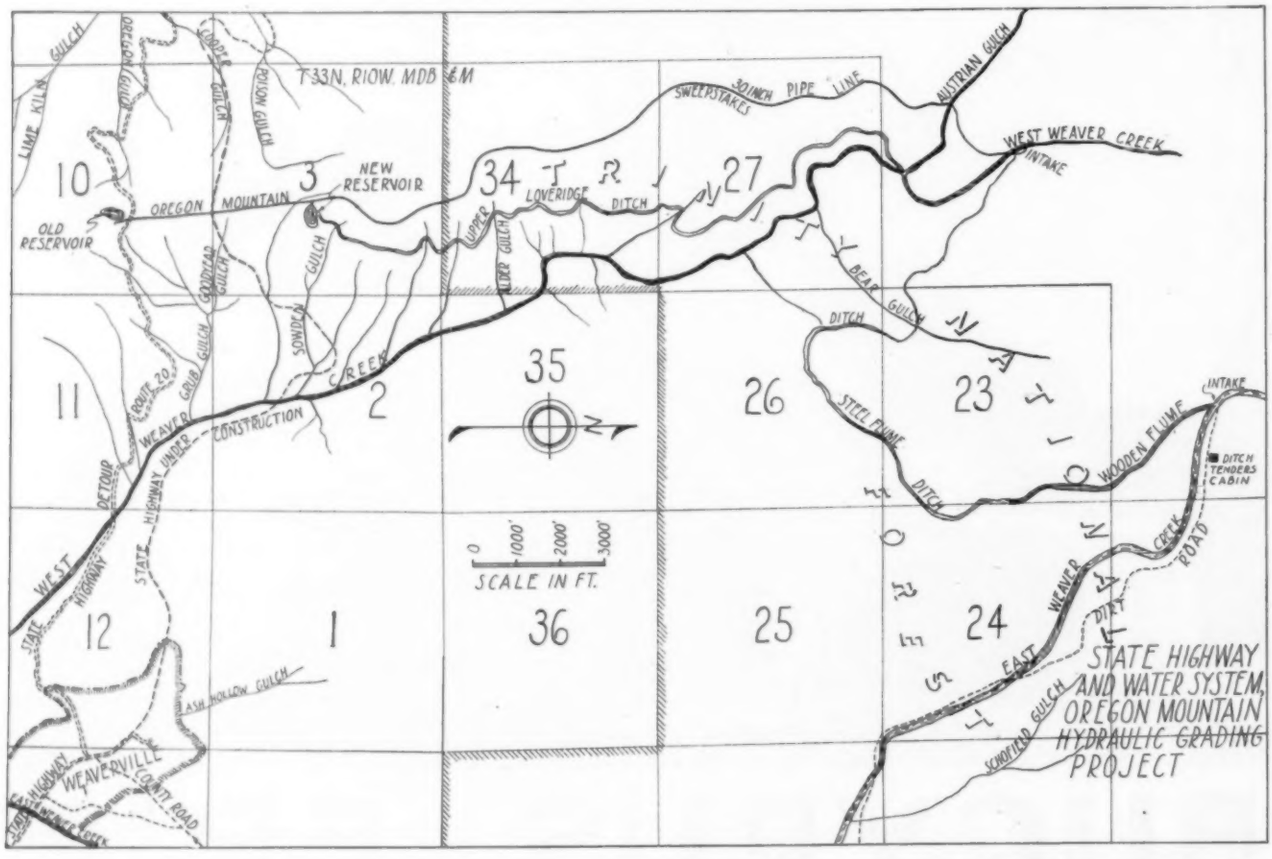
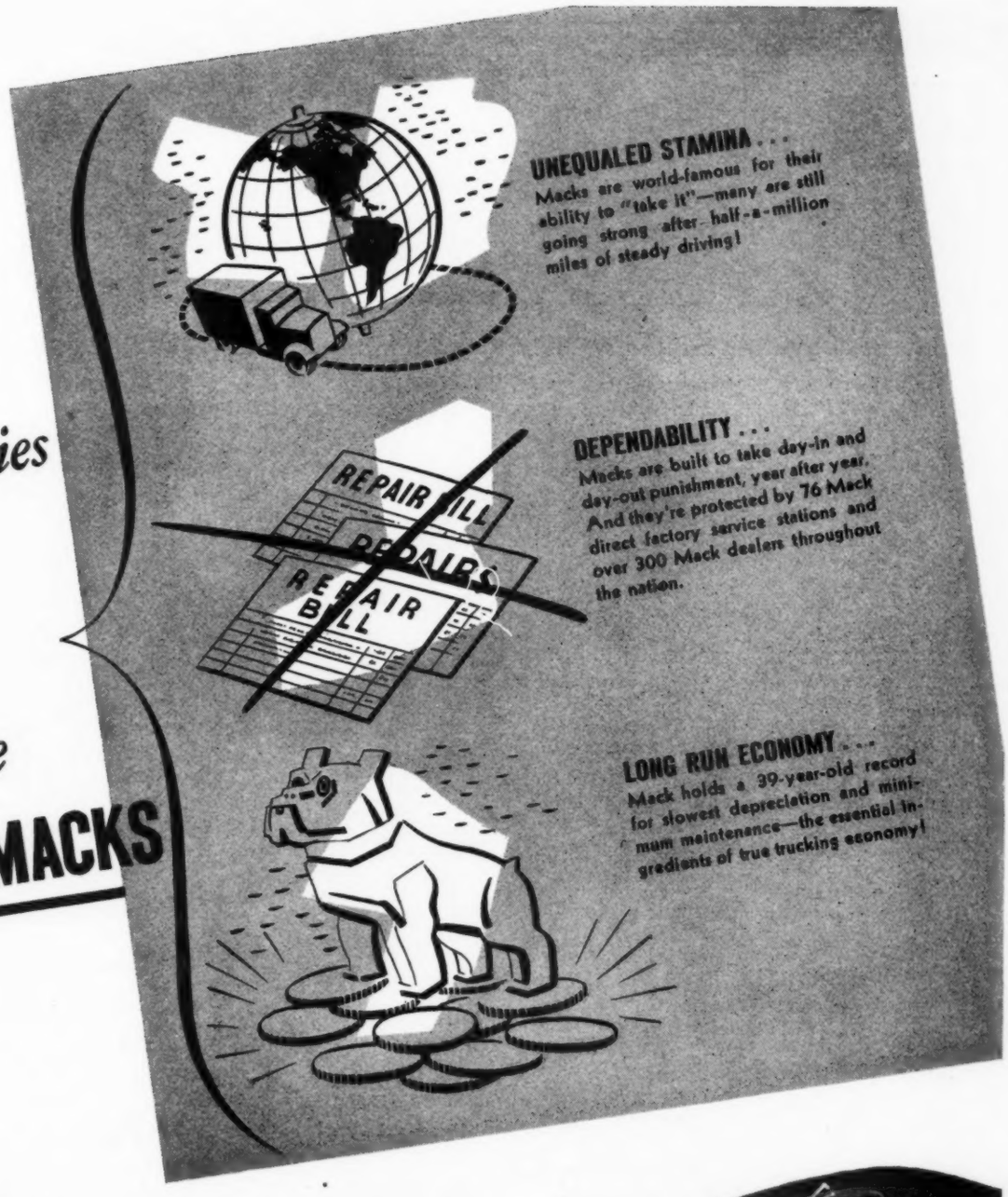


Fig. 1.—Water Collecting System for Oregon Mountain Highway Hydraulicking Job



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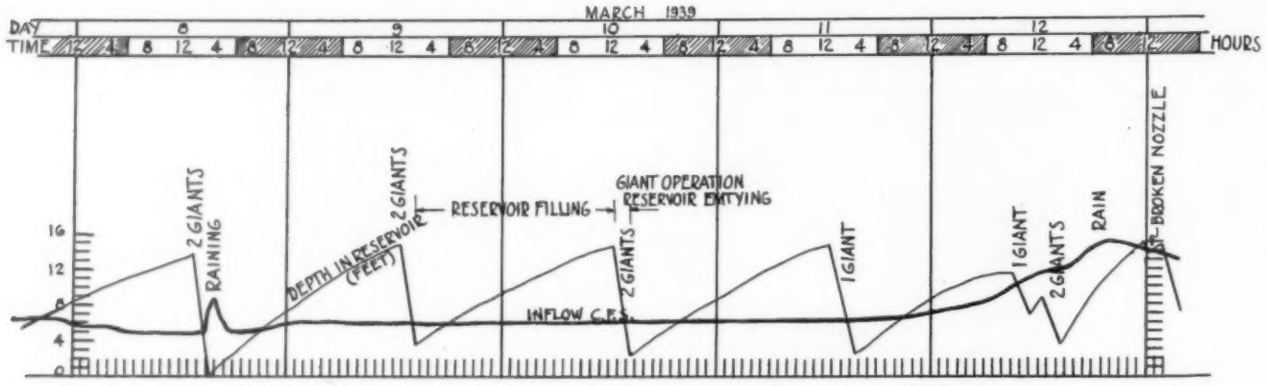


Fig. 2.—Curves Showing Fluctuation of Inflow and Control of Outflow of Reservoir

quarter of a million dollars has been allotted to lower this one cut so an 8 per cent ruling grade could be constructed. The balance of the mileage of new relocation from Weaverville west to Junction City saves about 2 miles in distance over the present road and is being constructed by convict forces and free day labor. In fact, some convict labor is also used in the hydraulicking work. Key positions and operators of equipment, however, are all free day labor. Oregon Mountain rises to a height of 1,200 ft. above Weaverville on the east and 1,500 ft. above the mouth of Oregon Gulch to the west, about 1 mile east of Junction City.

Interesting Background

For 30 years prior to the turn of the century and up until the World War, a placer gold mining operation was in progress on the slopes of Oregon Mountain. The mountain is mostly underlaid with deep gravel deposits that were fairly rich in gold, free gold. Estimates indicated there were 200,000,000 cu. yd. of gold bearing gravel in the mountain, of which only about 100,000,000 cu. yd. had been worked. There is no gold in the overburden. Placer mining kept proceeding up Oregon Gulch and Poison Gulch and on both sides until a very heavy overburden began to make gold recovery nonprofitable. The mining company was acquired by a Frenchman, Baron Le Grange, in 1892, but taxes imposed upon the company by its own foreign government during the World War sealed the fate of economic operation and the mine closed in 1918.

It was after the war that political maneuvering and pressure influenced the road as now traveled to become a part of the state highway system, as against the more economical water level route following Trinity River from

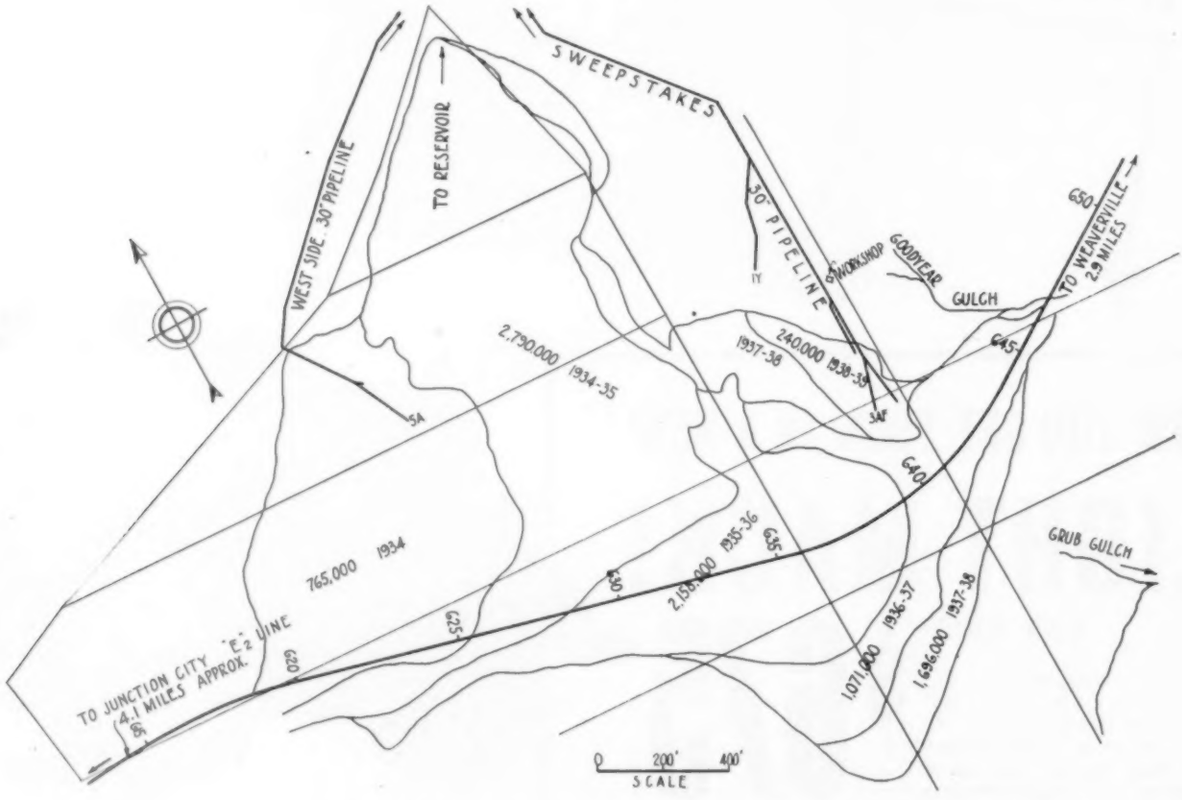
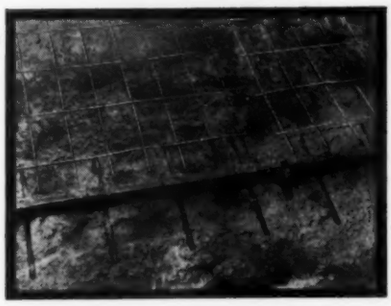


Fig. 3.—Plan of Excavation Operations Showing Yardages Moved

Here's a Road Laid to LAST!



Close-up showing how *Pittsburgh Reinforcing* is laid in combination with an expansion joint in a typical modern installation.

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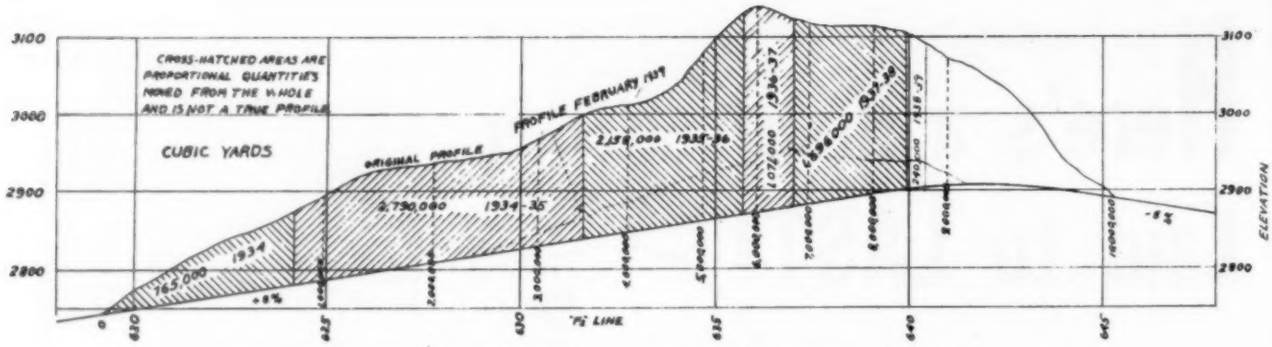

Fig. 3a.—Time-Quantity Diagram of Progress Platted on Profile of Cut

a point about 7 miles east of Weaverville to Junction City on the west. This would have left Weaverville (a county seat) to be reached by a lateral road. 'Twould probably have been much more economical to have built ville and thence west over Oregon Mountain on 12, 15, and 18 per cent grades, and down again over like grades to Junction City on Trinity River.

District Engineer Haselwood, having a complete

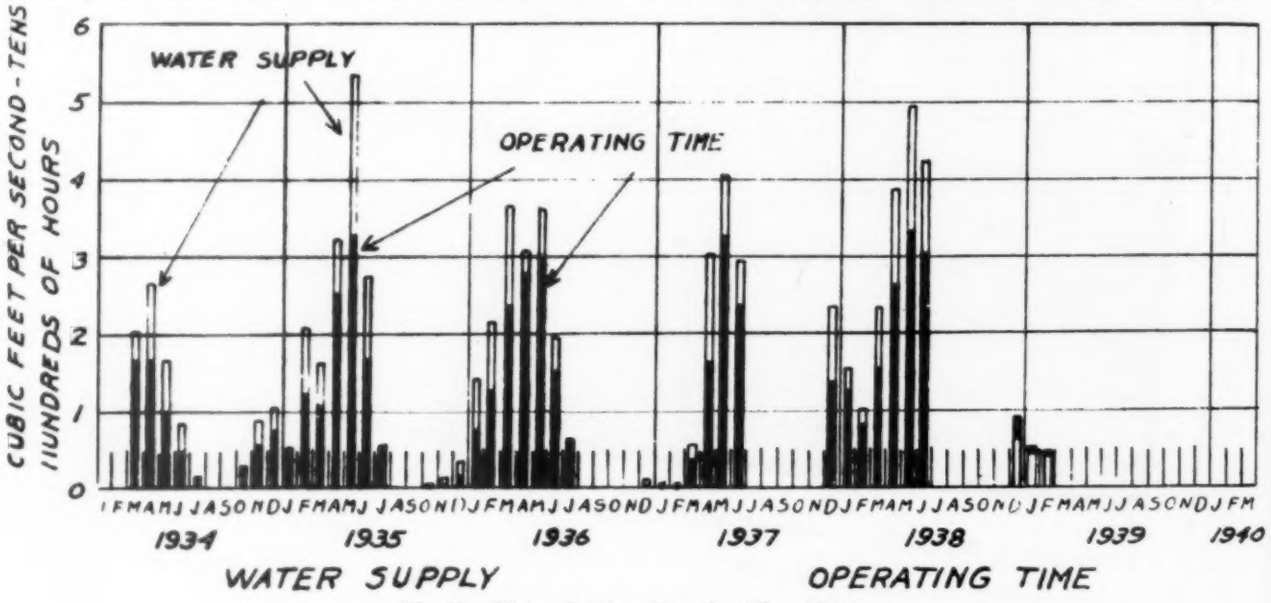

Fig. 3b.—Water Supply—Operating Time Chart

a new town on Trinity River at Douglas, moved Weaverville down there, and abandoned the present town. Be that as it may, the adopted routing went to Weaver-

knowledge of the political lay of the land as well as of the topographical lay of the land, and knowing about the placer mine equipment and its earth moving pos-

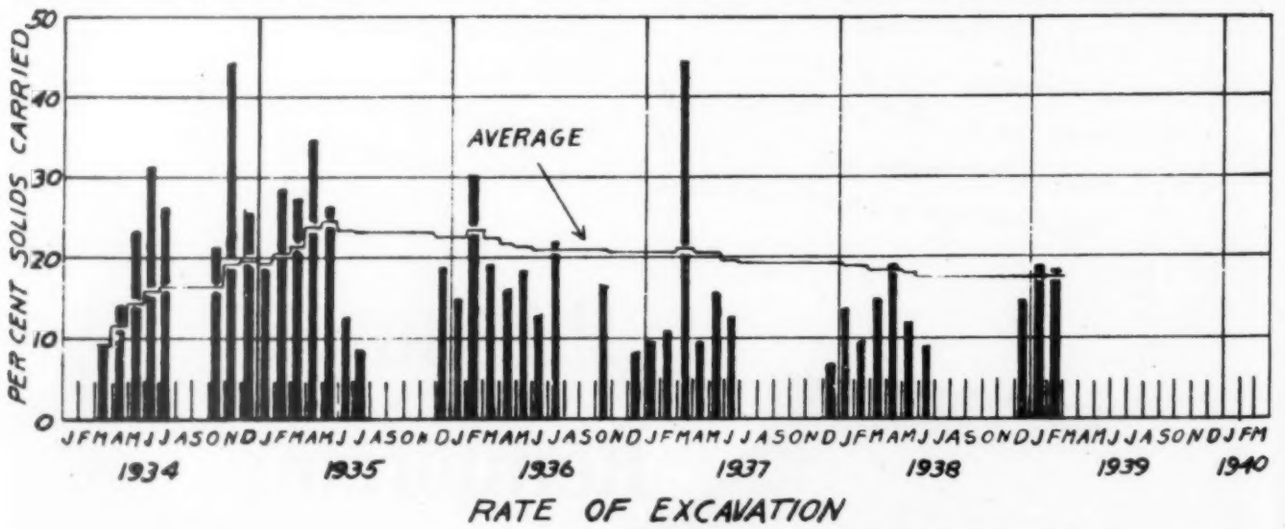

Fig. 3c.—Rate of Carry by Months

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KOEHRING COMPANY · *Milwaukee, Wis.*

Koehring Longitudinal Finisher on a highway paving job with high speed Koehring 34-E Twinbatch Paver, keeping pace with the high speed paver production.

KOEHRING HEAVY DUTY

HEAVY-DUTY CONSTRUCTION EQUIPMENT

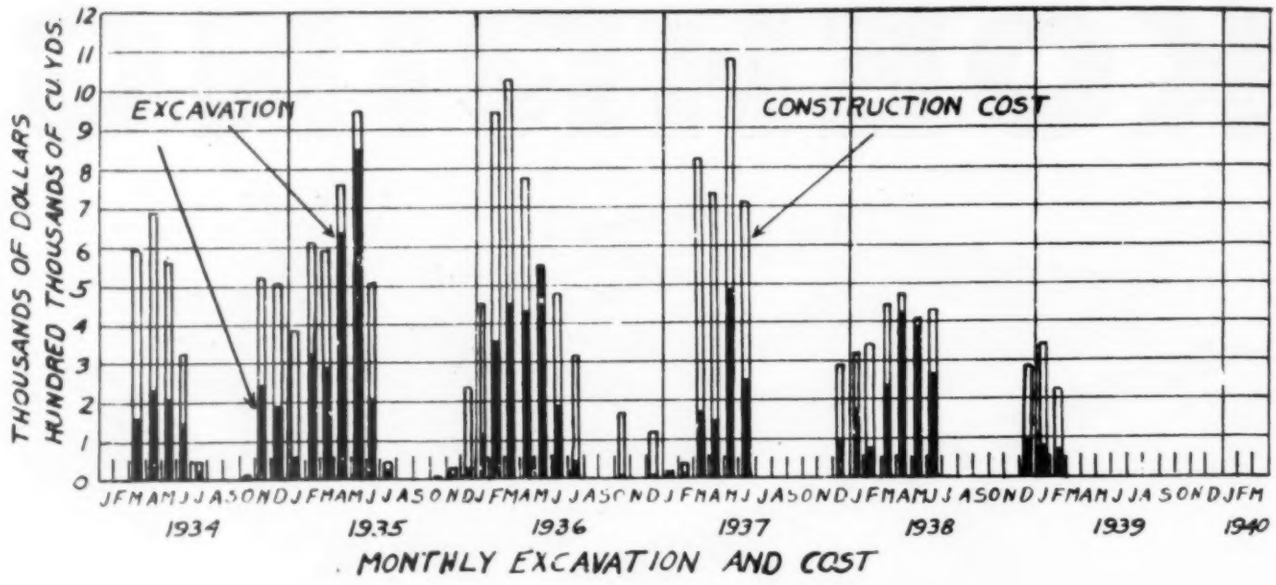

Fig. 3d.—Monthly Volume of Excavation and Total Cost per Month

sibilities, as well as knowing what impossible difficulties had to be conquered to get a maximum 8 per cent grade over Oregon Mountain, added up his facts and suggested hydraulicking the saddle on the mountain as a solution for the crossing. Finally, as stated, in 1934 operations commenced on a definitely programmed 6-year plan that has progressed according to schedule.

In any hydraulicking process four conditions must be satisfied for economical operation:

1. Adequate water supply in large volumes.
2. Pressure head strong enough to blast the embankment.
3. Uncemented material and absence of solid rock within excavation boundaries.
4. Outfall grade sufficient to maintain a high percentage of "carry."

All of these were present in this project.

Water Supply

The key to operations of this character is the water supply. A fair knowledge of placer mining operations at the site indicated closely what could be expected. The plan adopted was to rent all of the mining company's equipment and system of water supply. For this, the project pays the mining company a $750 per month rental. The agreement between the state and the mining company which owns all the lands or has control over them, is that the state can build the highway anywhere it wishes and take as much right of way as needed for excavation and waste. The state, upon completion of the highway, must return the water supply system and equipment to the mining company in good operating condition. The plat in Figure 1 shows the Sweepstakes system of flume, ditch, pipe and reservoir which furnishes water for the job. There are

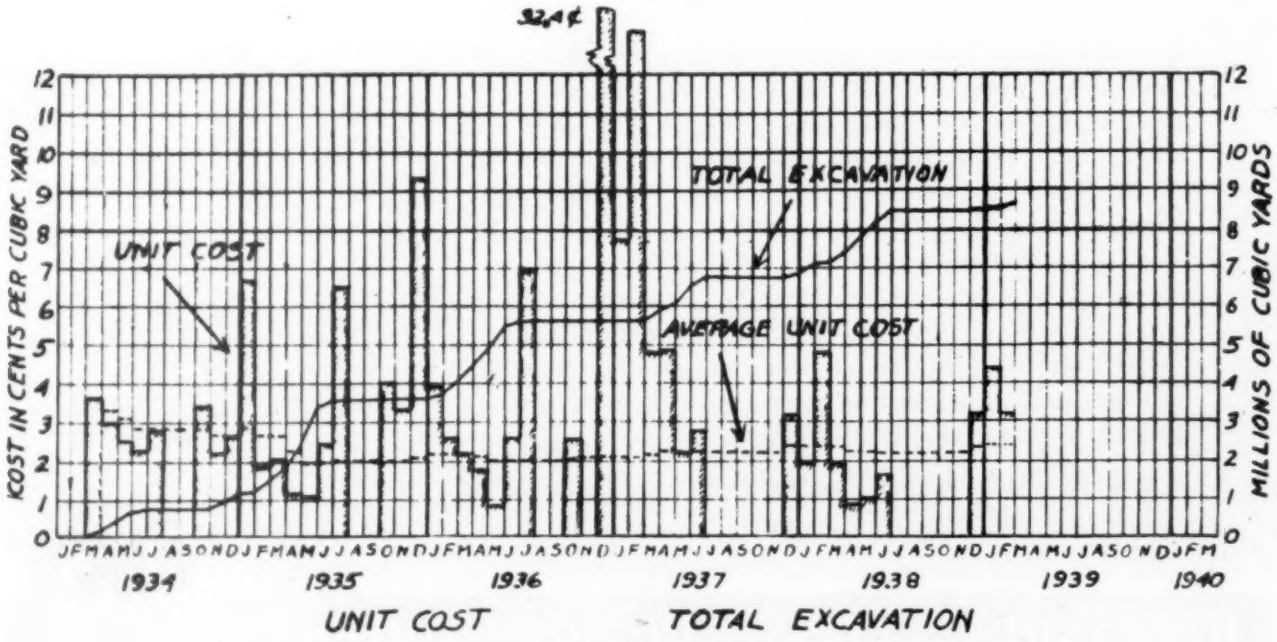

Fig. 3e.—Unit Cost and Accumulated Excavation

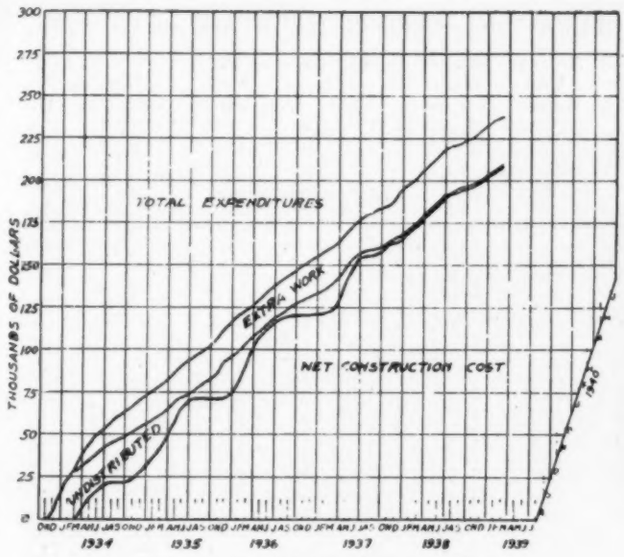

Fig. 3f.—Total Expenditures to Date

7 miles of 30-in. riveted steel pipe and 4 miles of ditch and flume in the collecting system. Other trenches and water collecting systems of the old Grange Mining Co. are shown but the one being used by the state is the Sweepstakes system. Dotted lines on this plat at the left show the location of the present road, labeled as State Highway Detour Route 20, and the location now nearing completion.

The reservoir on Oregon Mountain is the collecting basin for water that operates the giants. This reservoir is near the top of the mountain on the north side of and directly over the site of the highway cutting operations. All of that saddle shown on the plat where the words "Oregon Mountain" appear, and between the old reservoir and the new reservoir, and for 3/8 mile each way (east and west) is the approximate area of excavation by monitors.

Fig. 5a.—Closeup of Monitor Showing Night Light.

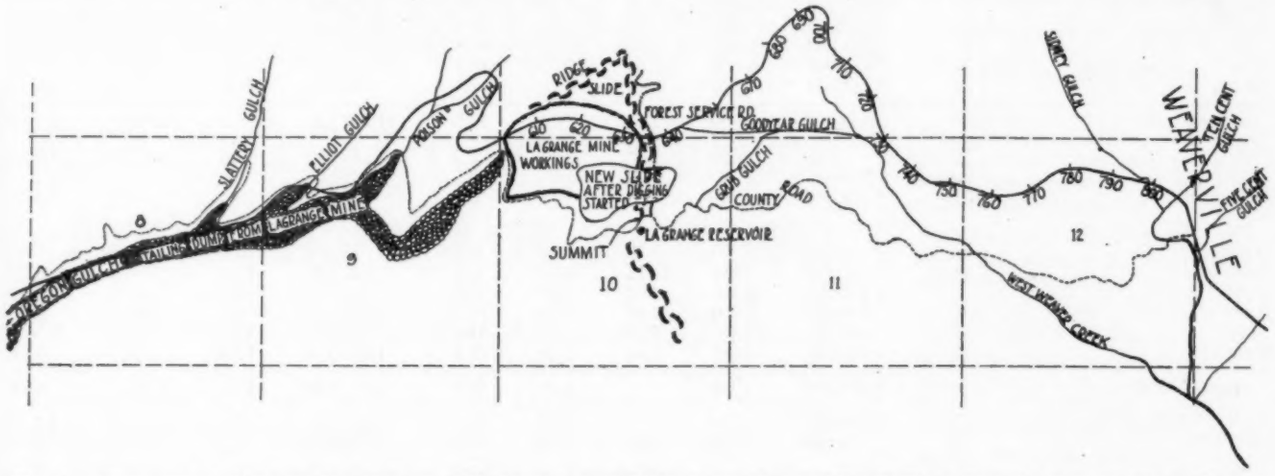

Fig. 4.—Alignment of Old and New Routes. Old Diggin's and Slide Areas Shown With Tailings Deposit Area on West. Eastern Tailing Deposit Area Not Shown

Fig. 5.—Closeup of Monitor or Giant. The Fine Spray Is Caused by Roughness on Ring of Monitor. Note How These One-Ton Giants Are Loaded to Hold Them in Place. Top Beam Is a Counterbalance

Water cannot be turned on at any time like a faucet in a house. A definite quantity collects and is available from the reservoir, which is nothing more than a small collecting basin, at regular intervals. Rains have the effect of causing night operation in order to take full advantage of all available flow. The chart, Fig. 2, shows the data collected by the man at the reservoir who controls the flow of water to the monitors. The more or less horizontal line shows a rise about 4:00 p. m. on March 8, 1939. That rise was caused by rain. It will be noted that both monitors (giants) were working and continued to work through the rain until the reservoir was emptied. The horizontal line is the inflow measurement in cubic feet per second and the sawtooth line shows the depth of the reservoir in feet, hour by hour. It will be noted that about 22 hours' time is required to collect enough water to operate both monitors for 2 hours. These characteristics vary with the precipitation.

TABLE I.—SUMMARY OF HYDRAULIC GRADING OPERATIONS—OREGON MOUNTAIN GRADING

1934—Mo.	Days Per Mo.	Excavation Cu. Yds.	C.Y. Per Day	Monthly Unit Cost c	Average Unit Cost c	Water Supply C.F.S.	Monthly Vol. Water C.Y.	Per Cent Solids	Hours Operated	C.Y. Per Hour
March	32	162,000	5,060	3.69	3.69	16.6	1,695,850	9.5	202.5	800
April	30	231,000	7,700	3.00	3.28	16.7	1,602,450	14.4	264.5	870
May	31	215,000	6,930	2.57	3.03	9.3	920,850	23.4	164.2	1,310
June	30	141,000	4,700	2.28	2.89	4.7	450,700	31.3	82.2	1,720
July	12½	16,000	1,280	2.86	2.89	1.5	60,590	26.4	11.7	1,370
Season total	135½	765,000	5,650	2.89	....	10.9	4,730,440	16.2	725.1	1,060
October	1	2,000	2,000	3.43	2.89	2.9	9,400	21.3	1.8	1,090
November	30	233,000	7,770	2.27	2.75	5.4	519,040	44.8	88.6	2,630
December	31	182,000	5,870	2.77	2.75	7.3	714,150	25.5	103.4	1,760
1935—Mo.										
January	31	57,000	1,840	6.79	2.94	4.4	434,260	18.5	51.2	1,110
February	28	318,000	11,360	1.94	2.73	12.2	1,102,670	28.8	207.9	1,530
March	31	288,000	9,280	2.07	2.63	10.5	1,045,150	27.6	161.7	1,780
April	22½	636,000	28,270	1.20	2.26	25.3	1,822,150	34.9	322.9	1,970
May	31	849,000	27,390	1.11	1.97	32.5	3,225,670	26.3	542.3	1,570
June	30	204,000	6,800	2.49	2.00	16.7	1,606,520	12.7	278.8	730
85th, 86th Biennium total	371	3,534,000	9,520	....	2.00	12.8	15,209,450	23.2	2,483.7	1,420
July	14	21,000	1,500	6.54	2.03	5.8	260,520	8.1	47.1	450
Season total	249½	2,790,000	11,180	....	1.79	13.5	10,739,530	26.0	1,805.7	1,550
October	15	1,000	60	....	2.03	0.5	25,600	10.0	0.8	1,240
November	30	9,000	300	3.33	2.03	0.5	50,300	17.9	11.4	790
December	31	25,000	800	9.36	2.08	1.3	131,370	19.0	34.9	715
1936—Mo.										
January	31	114,000	3,690	3.96	2.14	7.7	769,930	14.8	140.8	810
February	29	359,000	12,400	2.64	2.18	12.9	1,185,500	30.3	214.8	1,670
March	31	450,000	14,500	2.28	2.19	23.6	2,319,400	19.4	412.5	1,090
April	30	430,000	14,300	1.81	2.16	27.9	2,670,000	16.1	306.8	1,400
May	31	545,000	17,600	0.86	2.03	29.9	2,972,000	18.3	359.8	1,510
June	30	182,000	6,070	2.63	2.05	15.0	1,445,700	12.7	194.8	935
July	10	43,000	4,300	....	2.11	6.4	198,400	21.8	27.4	1,570
Season total	268	2,158,000	8,050	....	2.26	13.7	11,767,730	18.3	1,704.0	1,260
October	15	2,000	130	2.51	2.11	0.3	12,100	16.5	2.0	1,000
November	30	None	...	....	....	0.1	9,000	....	...	...
December	31	3,600	100	....	2.13	0.4	34,850	10.3	8.2	440
1937—Mo.										
January	31	2,400	80	7.70	2.14	0.3	25,410	9.4	4.5	535
February	28	3,000	110	13.11	2.14	0.3	27,220	11.0	4.8	625
March	31	170,000	5,480	4.82	2.22	3.8	381,070	44.6	72.5	2,340
April	30	150,000	5,000	4.84	2.28	16.5	1,586,070	9.5	301.6	500
May	31	488,000	15,700	2.22	2.28	32.6	3,232,370	15.1	404.6	1,200
June	26	252,000	9,680	2.81	2.30	23.7	1,977,370	12.7	298.3	840
Season total	253	1,071,000	4,240	....	3.28	12.4	7,288,700	14.7	1,096.1	980
87th, 88th Biennium total	535	3,250,000	6,100	....	2.62	11.3	19,056,430	17.1	2,847.2	1,140
December	32	93,000	2,900	3.2	2.42	13.9	1,394,400	6.7	235.0	400
1938—Mo.										
January	31	170,000	5,480	1.9	2.41	12.7	1,260,500	13.5	157.4	1,080
February	28	73,000	2,600	4.8	2.43	8.3	741,300	9.8	102.3	710
March	31	232,000	7,500	1.92	2.42	15.6	1,551,800	15.0	233.1	1,000
April	30	476,000	15,900	0.88	2.32	26.3	2,518,600	18.9	386.7	1,960
May	31	393,000	12,700	1.04	2.26	33.1	3,286,630	12.0	497.1	790
June	30	259,000	8,600	1.66	2.24	30.2	2,860,220	9.0	421.4	615
Season total	213	1,696,000	7,950	1.58	....	20.0	13,613,800	12.5	2,033.0	830
December	31	90,000	2,900	3.18	2.36	6.2	618,000	14.6	91.1	990
1939—Mo.										
January	31	80,000	2,600	4.36	2.38	4.3	430,500	18.6	52.4	1,530
February	28	70,000	2,500	3.20	2.38	4.3	386,500	18.1	47.2	1,480
Total	1,209	8,720,000	7,200	2.38	....	12.8	49,575,200	17.6	7,502.4	1,160

Starting about midnight, March 12, 1939, rain began to increase the inflow. In order to utilize all water, both monitors worked till quitting time for a day shift. The reservoirs filled so rapidly that a night crew had to start operations. It so happened that a nozzle on one of the monitors broke and the reservoir level again rose until both giants were again working about 3:00 a. m. of the 13th of March. Figure 2 is a section of a continuous chart that is the key to squirting operations.

One man at the gate valve to the outlet of the reservoir into the penstock of the two giant monitors controls the water supply to them. Another man patrols the conduit, flume, and ditch supply system; removing slides and debris, and fighting snow. These two men have telephonic communication with the workhouse near the hydraulicking and with the resident engineer's office on the worksite.

The 7-mile conduit line is 30 in. steel pipe. The penstock is 30-in. and 26-in. steel pipe which branches

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In every detail, the quality of all Ford cabs and bodies matches the high quality of Ford chassis. Their exceptional durability means long service with low up-keep cost.

Fig. 6.—View of Hydraulicking From Top of Opposite Side of Cut

into a Y of 18-in. lines to the two monitors, thence through what is called a "gooseneck," but which is in reality a ball-and-socket joint, to a 9-in. outlet. As the penstock goes down the slope and the head increases, the diameter of the pipe decreases. The monitors operate under about 480 ft. head or about 200 lb. per sq. in. pressure, which requires that they be heavily loaded to hold them in place when operating. Footing and pipe bedding must be solidly firm. The average rate of flow

Fig. 7.—Stream About at Maximum Operating Range for Efficient Operation

from the giants is 55 sec.-ft. at this head. The average "carry" from the hydraulicking has been calculated at about 18 per cent. (See Table I.)

Slides

As stated before, sliding of overburden became a troublesome, uneconomic factor in placer mining operations. Likewise, in order to lower the crest of the mountain 230 ft. the whole mountain side on either side of the center of cutting began sliding. The slide to the north traveled at the rate of 1½ ft. per month. Large crevices developed on the mountain top 500 ft. (horizontally) from the center of cutting. The drop of slides ranged from 3 ft. to 25 ft. on the mountain top. This characteristic of the side slopes made it quite evident that all of the sliding material would have to be washed out to prevent damage to the new roadway. At the time the writer viewed operations, the slides on the south side had caused material in the bottom of the cut, near the toe of the slides, to raise about 5 or 6 ft.

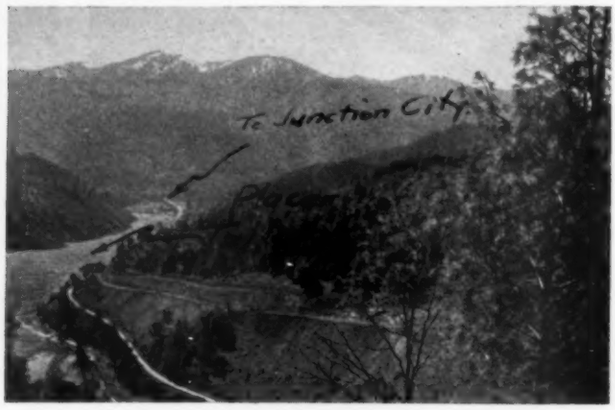

Fig. 8.—View of New Road on Slope of Poison Gulch West From the Hydraulic Cut

The face of the slide is about 200 ft. high and 800 ft. long. On top, from the edge of the slope to the back edge of the slide is about 350 ft. (estimated).

Excavation

The diagrams and plat of Fig. 3 show hydraulicking operations from the beginning of the project. Work started on the west slope of the saddle and progressed eastward, north of the proposed center line of the highway. The mass diagram (Fig. 3a) shows the yardage moved to date. (Also given in Table I.) No work is permitted between July 1 and Dec. 1 in order to keep streams clear for fishing. The various Figs. 3, a to f, inclusive, are self explanatory.

Figure 4 shows the proposed alignment and slip areas in the cut.

A summary of grading operations is given by Table I. Cutting is accomplished by directing the stream at the foot of the cut, undermining it and causing heavy sloughing; the heavier the sloughing, the greater the carry. Average movement is about 1,500 cu. yd. per operating hour. When the stream is longer than 300 ft. the giant is moved.

Using ordinary tools for excavating by ordinary

Fig. 9.—View Looking East Along Proposed Centerline Toward Hydraulic Cut Pine Tree Is Just Off the Centerline on the Right. Bulldozer in Background Is Preparing Construction Road. Pick Gives Relative Idea of Size.

Wherever Good Roads are built

Puerto Rico may lag behind Indiana in road construction *methods*. But in choice of *materials*, road builders of this island are no less exacting than those of Indiana.

Each of the projects pictured here is of the pre-mix, low-cost asphalt type. Whereas Indiana employed modern, mechanical methods in spreading the mix, Puerto Rico spread by hand. However, in both instances, TEXACO Asphaltic materials were selected as the binding medium in the road surface.

Despite the widely different climatic conditions of Puerto Rico and Indiana, TEXACO Asphalt streets and highways provide the same lasting, economical service in both places.

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Fig. 10.—Slide Which Let Loose on North Side of Centerline.

methods, the monitors move as much material as eight average size power shovels with more than 30 average trucks hauling it away. The final excavation was planned to be 100 ft. wide at the bottom; however, because of unexpected sliding on the south, it will be much wider. These large monitors move materials that would have to be blasted by ordinary methods of excavation.

Conclusion

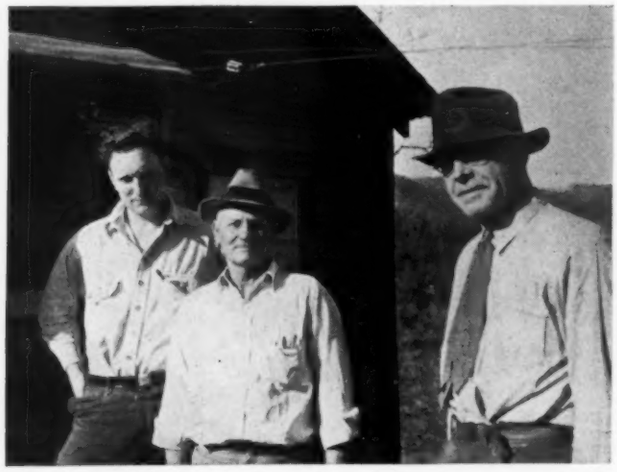
Oregon Mountain, which lies directly across the path of the proposed highway will shortly be conquered by a directly up and over highway. When mountains get in the way of highways they must be moved. What took thousands of years to do by natural processes in the Cretaceous age is undone by man in the twinkling of an eye, as geologists reckon time. Traffic will flow through Oregon Mountain next winter on or near the bed of a stream made millions of years ago.

Those responsible are:

F. W. Haselwood, District Engineer, California Division of Highways.

H. L. Waste, Superintendent of Construction.

Fig. 11.—Slide on South Side Yet to Be Removed. Peak in Background Was Original Ground Surface, Indicating a Drop of About 25 Ft. Note the Many Crevices Formed by Progressive Movement. This Is Only a Small Portion of the Entire Slide



Left to Right—Mr. R. L. Gerry, Resident Engineer on the Hydraulicking, Calif., Division of Highways; Mr. R. E. Ward, Resident Engineer for Whole Project. Mr. H. L. Waste, Superintendent of Construction for the State

R. E. Ward, Resident Engineer on whole project.

R. L. Gerry, Resident Engineer on hydraulicking.

It may be an interesting side light to know that the moving picture, "Gold Is Where You Find It," was filmed on this site.

▼

RECORDING COST OF SNOW REMOVAL

Snow plow operators for Middlesex County, Ontario, are supplied with a blueprint map showing patrol sections, a separate map for each 24 hours' operations, on which the operators mark with colored lines their various trips. A single cut with the plow is marked with one line; a return trip with a double line. The object of this is to simplify the method of obtaining the cost per mile and the cost per patrol section of snow plowing. The maps are returned to the County Engineer's office each week, and the mileages are taken off the maps and recorded on a record sheet according to patrol sections. At the end of the year a complete record will be availabe of the cost of keeping each section clear of snow. This, over several seasons, will enable the county, and the county engineer to decide where additional snow fences are necessary to aid the equipment available.

▼

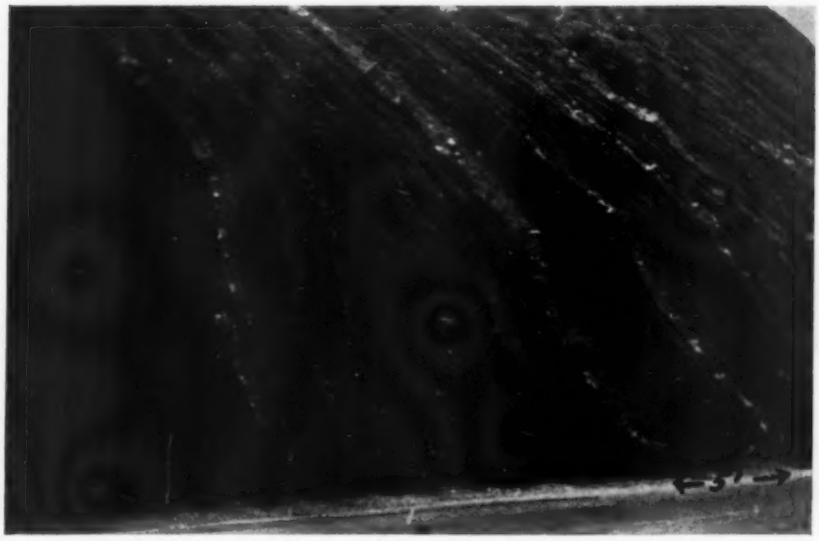
TRAFFIC SAFETY FELLOWSHIP—Seven Alfred P. Sloan, Jr., traffic safety fellows, providing an academic year's training in the specialized field of traffic control will be awarded to engineering employes of state highway departments. Engineers must be between 21 and 30 years of age. The fellowship provides $1,400 for living expense, field travel and tuition. The training will be at the Yale Bureau for Street Traffic Research. Applications may be secured from Maxwell Halsey, Associate Director, Yale Bureau for Street Traffic Research, New Haven, Conn.

DRY YEARS AHEAD

By HALBERT P. GILLETTE

FOUR years ago I published two papers forecasting that the rainfall curve would continue its downward trend for several years. It was shown that the trend had been downward for more than 60 years in many regions, and that this long decrease was apparently due mainly to a cycle of about 152 years. Tree-rings supplied the main evidence as to the length of this "grand cycle," as its discoverer, Keele, had called it. Dr. Ellsworth Huntington had rediscovered it in tree-rings and had called it 155 years.

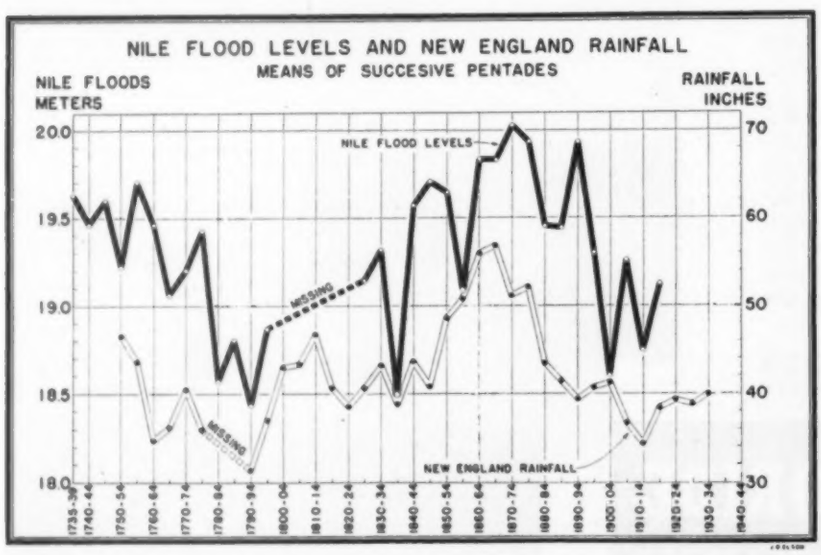
A synopsis of my paper was broadcast by "The March of Time" which led to widespread discussion as to the outlook for a cessation of "dust bowl conditions." Quite recently the Weather Bureau has cautiously suggested that perhaps the end of the very dry period is at hand. But obviously such a statement can be no more than a guess unless it is supported by evidence as to the length of one or more long cycles. Moreover the downward trend in rainfall and upward trend in temperature that have continued since about 1872 indicate a cycle of at least twice 67 years in length. Hence even if an upward trend were at hand it would mean a very slow return to normal. Unfortunately recent analyses of additional data give no hope that the bottom of the rainfall curve will occur for another 27 years. The additional data to which I refer are Schastokowitsch's measurements of varves in the mud of Lake Saki, Crimea, and my own measurements of varved rocks in California. In two recent articles in the Pan-American Geologist I have discussed the latter, in which cycles of 21, 63, 189, 567 and 1701 years are most prominent.



View in Highway Cut Near Los Angeles, Showing Alternating Beds of Sandstone and Shale

A varve is an annual layer of sediment deposited in a lake or ocean. Although the relative thicknesses of varves gives only a rough measure of the runoff, they serve splendidly as a means of determining the lengths of weather and climatic cycles. For this purpose I find that varves are superior to tree-rings, as will be explained in a paper to be read at the June meeting of the American Meteorological Society.

The Lake Saki varves that have been measured go back from the present to 2300 B. C., and therefore give an annual record 1000 years longer than that of the oldest California sequoia yet measured. My analyses of these varves shows a cycle of 147 years, or about 3 per cent shorter than the estimated length of the "grand cycle" that I published in 1935. These Lake Saki varves also show a cycle of 189 years which I had previously found in rock strata, lake terraces and recessional moraines. Both cycles (147 and 189) had coincident rainfall peaks or maxima in 1872. Hence their next minima will ocur in 1945 and 1966 respectively. Of these two cycles the longer one is ordinarily the more pronounced in its extreme departures from a mean. This was strikingly the case at their last rainfall minima in 1798 and 1777, as will be seen by reference to the accompanying New England rainfall curve and the Nile levels. A dry period started in England in 1779 that lasted till 1815. At Paris it was very dry from 1790 to 1797, the drought ending in 1810. In Australia there was a very severe drought but how long prior thereto is not known because white men first settled there in 1788. In California



Nile Flood Levels and New England Rainfall; Means of Successive Pentades

the Spanish padres recorded a drought between 1781 and 1810. New England rainfall and Nile flood levels proclaim similar experiences.

The rainfall minima of the 189, the 567 and the 1701-year cycles will be coincident in 1966 A. D., insuring greater dryness then than about 189 years earlier.

I have found good evidence that all weather and climatic cycles are harmonic; hence that long cycles result from the combined effects of short cycles; hence the least common multiple of the lengths of any two or more cycles is the length of a compound cycle. All the short sub-cycles of the 147 and the 189 year cycles had coincident maxima of rainfall March 7, 1872. Since the least common multiple of 147 and 189 is 1323, they had a previous coincidence of maximum rainfall in 549 A. D.

There is evidence of 8 triple-progression series of cycles. The lengths of cycles in each series form a geometrical progression series whose ratio is three. Designating each series by a letter, the following is the length in years of one cycle in each series: A, 3; B, 5; C, 7; D, 49; E, 189/11 (or 11.12 nearly), which is the great Schwabe sunspot cycle; F = 2 E/11; G = E/7; H = E/13.

Series F causes alternate peaks of series E to be higher; e.g., the well known alternation in the maxima of the 11.12-year sunspot cycle. One of series E is the cycle of about 2.0214 years, commonly called "the two year cycle," as to which at least a score of meteorologists have found evidence. Two of the cycles of series D are also very well known, namely, the 49-year cycle, which is commonly called 50 years; and the cycle of 49/9, or 5.44 years, which has usually been mistakenly regarded as being half the length of the 11.12-year cycle.

Not only are there cycles of 3, 9, 27, 81, etc., times the length of each of the lengths above given, but also cycle of 1/3, 1/9, 1/27, 1/81, etc., times the lengths above given.

All the cycles of the 8 series, A to H, had coincident rainfall maxima the 7th of March 66, 923 B. C. which is the date of the peak of a very long geological and climatic cycle that will be discussed in future articles. By calculating forward from 66, 923.182 the peak dates of any cycle of the 8 series may be found. Thus the 1701-year cycle had its last rainfall maximum 1116.182 or March 7, 1116 A. D. Hence all other shorter cycles of series C also had a rainfall maximum then. Precision both as to dates and lengths of very long cycles may seem fantastic, and it would be impossible were it not that the long cycles are the result of the combined effects of short cycles as to which precision is attainable.

The long climatic cycles of series C (63 years and longer) have greater amplitudes, or up and down swings, than those of about the same length in any other series. Next in importance are those of series D (49 years and longer). The 567-year cycle of series C is very conspicuous in rock strata, being often shown by long series of pairs of beds, each pair recording a cycle. Thus in California, pairs of shale and sandstone, each pair covering about 5 ft., show the 567-year cycle remarkably often and well. The varves in California rock average about 1/10 in. in thickness, all along the coast and valley highways between Los Angeles and San Francisco.

If it seems "too good to be true" that weather and climatic cycles form a great harmonic system, bear in mind that Nature has a way of being mathematical in its orderliness. It is therefore improbable that weather is as chaotic as it has seemed.

At least five factors have combined to give an illusory appearance of chaos in weather. First, the large number of cycles; second, the relatively short time that man has kept weather records (in America few stations carry back even a century); third, regional differences as to topography and proximity to the sea; fourth, periodic shifting of storm tracks; and fifth, opposite simultaneous effects due to the "semi-permanent" cyclones and anticyclones in different regions. Clayton and Huntington have independently called attention to the last named or fifth factor. Bigelow and Kullmer have independently discovered some of the effects of the fourth factor. Nearly every cycle researcher in the last 20 years has added evidence as to the large number of cycles. Had it not been that Nature had left records of cyclic changes in tree-rings, varves, stratified rocks, lake and marine terraces, recessional moraines, etc., several hundred more years would have to elapse before man-kept records would suffice to establish the existence of all the cycles in series A to H. So long as many of these cycles were unknown, accurate long-range forecasting would have remained impossible. Even yet a great deal of work will be required to unravel the causes and discover the laws of regional differences in rainfall; but I am confident that success will reward researchers in that field also.

To one unacquainted with the fact that long cycles result from the combined effects of short cycles it would seem more difficult to forecast the effects of long than of short cycles. The contrary is the case, not merely because long cycles are fewer but because they have greater amplitudes and are less affected by local conditions. The accompanying photograph indicates how great and outstanding are the effects of the 567-year cycle. This picture was taken in a highway cut near Los Angeles where alternating beds of sandstone and shale occur. The coarse grained sandstone marks periods when rainfall and erosion were a maximum; whereas the mud, which later consolidated into shale, marks less rainy periods. In this shale thin laminae about 1/10 in. thick record the annual deposits of mud, and thus enable us to estimate the length of time involved in laying down each pair of shale and sandstone beds that registered a full cycle. The thicker sandstone beds are about 5 ft. center to center, marking peaks of the 567-year cycle. The intermediate thinner beds of sandstone mark peaks of the 189-year cycle. In one section I counted two dozen thick sandstone ribs that recorded the peaks of that many cycles of 567 years. In the face of such evidence, no doubt exists either as to the regularity of cycles or as to their profound climatic effects when they are long. Since a rainfall minimum not only of this 567-year cycle but of a cycle three times its length is what he world faces in 1966 A. D., there will be a period of dry years that has not been paralleled since those that culminated in Diocletian's famine in 301 A. D. For many years prior thereto the Roman Empire was so battered by hordes of desperate men, that its ultimate fall was portended in no uncertain manner. May not present wars and rumors of wars presage a similar end, for similar reasons, of many a powerful "empire"?

▼

PROGRESS ON GERMAN MOTOR HIGHWAY CONSTRUCTION—It is reported that 1,039 kilometers of the Reichsentobahnen motor highway were completed in 1938, making the total length of the highway opened to traffic on Jan. 1 3,065 kilometers.

▼

3-YEAR HIGHWAY PROGRAM FOR COLOMBIA—The National Government of Colombia has announced a 3-year highway improvement calling for surfacing 305 kilometers of road the first year, 316 kilometers the second, and 279 kilometers the third year.

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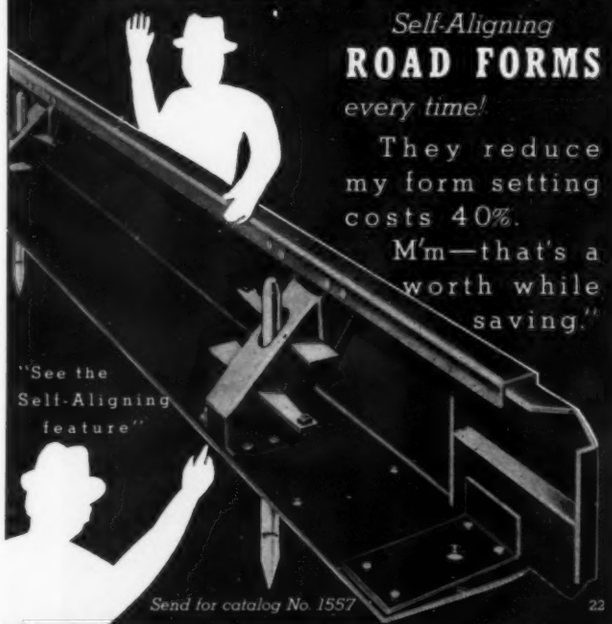

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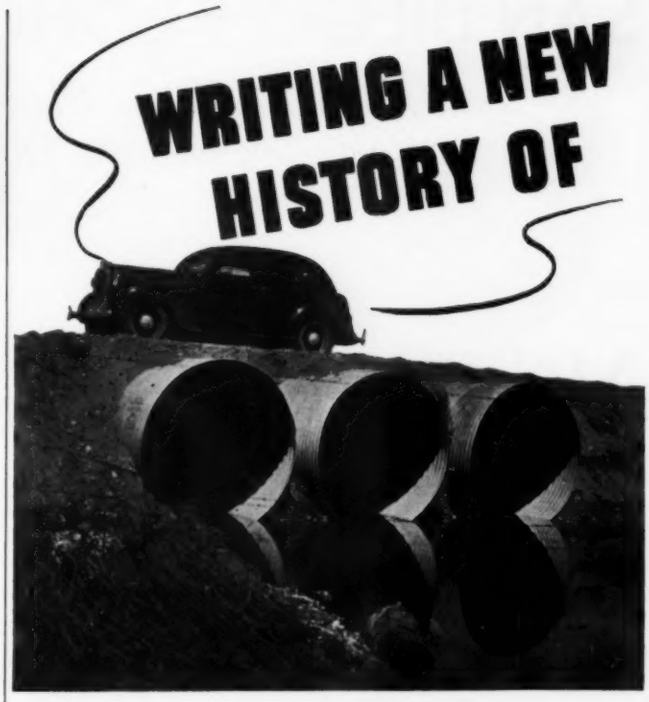

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SAN DIEGO'S LONG-TERM PROGRAM

A Comprehensive Plan in the Construction of Public Improvements During the Next 10 Years

By GLENN A. RICK
City Planning Engineer, San Diego, Calif.

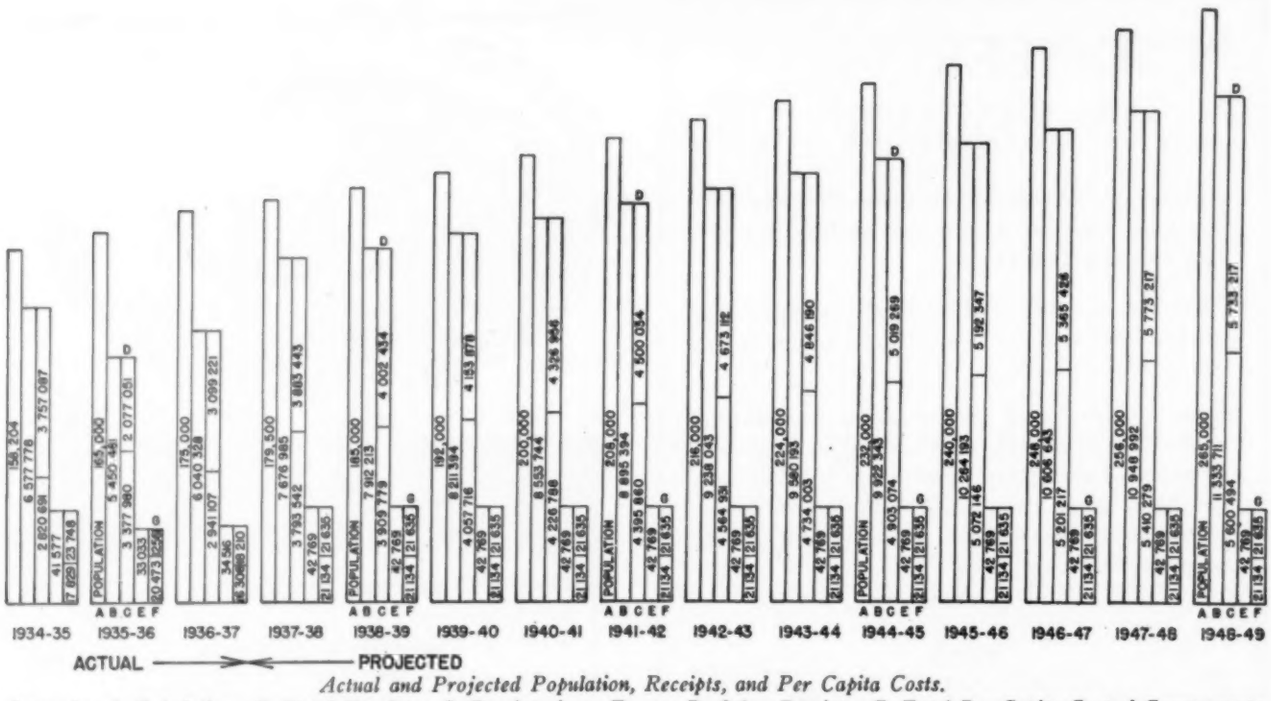
MODERN aviation makes use of instruments for "blind flying." The radio beam is considered indispensable to the pilot whether he can see the ground or whether he is flying through darkness or storm. A kind of radio beam for city administrators is the long-term program of public improvements. To stay on the true course of economy when buffeted by storms of "pressure groups" is difficult. The adoption of a long term financial plan will not guarantee the ultimate goal any more than a radio beam guarantees safe arrival of the airplane at its destination. But having such a guide helps any municipal pilot.

San Diego, not long ago, decided to outline its future course in "necessary and desirable" improvements and to fit them into a financial scheme whereby consideration could be given to the most urgent items as well as some improvements less pressing at the moment. The published report of this work indicates a future expenditure by plan of over $35,000,000. Streets, highways, bridges, and underpasses within the city account for nearly 30 per cent of this amount; and water development projects in this semi-arid region totals about 25 per cent of the whole. Storm drains, water mains, and sewers, together account for about 20 per cent. Public buildings, parks, and recreation, harbor development, and fire protection complete the program. These various groups are divided into eleven sub headings and in turn are broken down into over 400 items or projects.

These projects are all shown on the eleven maps contained in the report. The maps are on transparent paper and may be separately superimposed over a key map of the city which composes part of the rear cover of the report. Thus the location of each project may be identified and located with reference to the city as a whole.

The long-term program of capital expenditure for San Diego is based upon many existing plans. The four principal plans are the "Comprehensive Plan for San Diego," by John Nolen, 1926; the Major Street Plan, 1931; the Port of San Diego Plan, and the Water Development Plan. An analysis of these plans at the time the Long-Term Program was being prepared indicated that many of the items originally listed in them

Airplane View of Portions of San Diego Showing Several Proposed Street Projects. Point Loma and Pacific Ocean in Background. Actual and Projected Total Cost of City Government.



Actual and Projected Population, Receipts, and Per Capita Costs.

Legend: A, Population; B, Total Receipts; C, Receipts from Taxes; D, Other Receipts; E, Total Per Capita Cost of Government; F, Per Capita Cost from Taxes; G, Per Capita Cost from Other Sources.

had been completed; some partially done; and others neglected. In fact, a study of capital expenditures made during the preceding ten years revealed many interesting things. A brief summary of these improvements of a permanent nature is contained in the report. It was included partially to forestall anticipated criticism of proposed improvements.

Also, to assist in preparing the tentative position of relative importance of projects for the future, a detailed study of the amount of private expenditures for the past ten years was made. The principal source of these data was the building permit record. Maps and charts are included in the report showing the location of the 11,000 residential units constructed in the city's 27 districts over the past 10-year period. Thus, the trends of growth in various sections were studied. Sections of the city showing a consistent growth were favored with more public improvements in the future plan. In order that a limit be placed upon sectional demands a study was made of the probable population in each of the districts. This was done on the basis of the rate of growth applied to the building site vacancy and the density of population. In other words, a tentative figure was placed upon the ultimate population for some time to come.

The study of traffic flow diagrams was likewise useful in programming the various street improvements. Where the greatest congestion occurred, those areas were given positions of preference in the list. School enrollment and other data as public utility extensions were included as pertinent to this study. Although the difficulties in arriving at a correct area distribution of public improvements are very apparent, they are made on the basis of "if and when." Consequently this list or any list prepared for a long-time in the future must obviously be subject to change when such change is warranted.

The solution to the entire problem was not found in completing a summary of future improvements and tentatively giving each a position of relative importance. Studies and analyses of the city's financial condition were made by the fiscal officers and engineers. It takes a bold man indeed to say what any municipality, corporation, or even an individual will be able to spend each year for a number of years in the future. Past experience being the only source of data, figures were compiled showing the sources of income and the total cost of the city government. This cost was in turn broken down into outlay and maintenance. It was found that the graph showing capital expenditures had a direct relationship to the population graph. Estimates of future population were made and projections made on this basis and checked by per capita cost figures.

Naturally these figures may miss the mark very far for who could say just how many bonds the city will vote in the future. The relationship of bonded debt to these estimates is complex and interest charges on past debt incurred for public improvements will be obligatory and must be met.

It is contemplated this report will be useful in additional studies of the whole question of the municipality's public debt. Financial data contained in the report include a statement of the over-lapping debt for the city and county school districts; also, assessed valuation, tax delinquencies, tax rates and the relationship of actual tax income to anticipated tax income, all for the past ten years.

▼

PROGRESS ON BLUE RIDGE PARKWAY—At the present time approximately 160 miles of this parkway have been completed in Virginia, including the Skyline Drive through Shenandoah National Park. In North Carolina, 128 miles of the parkway either have been completed or are under contract. The Blue Ridge Parkway will extend from Front Royal, Va., to the Great Smoky Mountains National Park in western North Carolina and will be 480 to 500 miles in length when completed, with 230 miles in Virginia and approximately 250 miles in North Carolina.

METHODS OF JOINT DESIGN USING RUBBER

By G. J. IRWIN,
Engineer, The B. F. Goodrich Company
Akron, Ohio

ENGINEERS AND CONTRACTORS who have designed and built concrete highways are thoroughly acquainted with the problems involved in both the design and construction of expansion joints. The past decade has seen many improvements in equipment and methods for laying concrete pavement, but the development of a practical and economical expansion joint has been a subject of considerable study. The poured type of joint, which was most widely used, extruded too easily under compression and required constant maintenance. Many materials in various combinations have been tried in this service but none have met the requirements of a perfect joint or joint filler. Either there was some deficiency in their physical make-up or their cost was so high as to make them impractical.

Rubber Joint Filler.—The use of rubber as a joint filler is not a new idea. Various fillers composed of sponge rubber, latex mixtures, and rubber and cork have been tried with varying degrees of success. The problem after load transfer and shear were considered, as engineers of the B. F. Goodrich Company saw it, was twofold. First, the development of a joint design using rubber filler which result in a simplified as well as a functioning installation. Second, the development of a rubber compound which possessed satisfactory aging qualities and could retain its resilience under normal exposure.

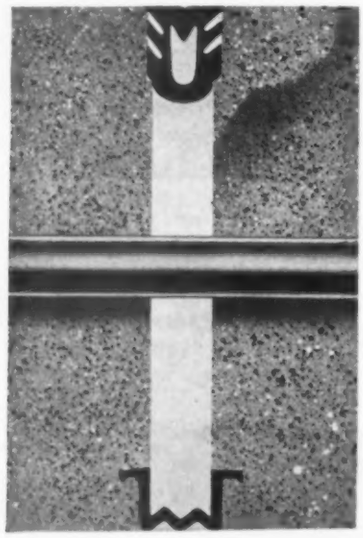


Fig. 1.—Showing Rubber Joint Seal in Place at Top of Slab. Bottom Is Also Sealed With Another Shape.

A filler strip developed by Goodrich provides a long life joint because it is made of a high tensile, elastic rubber that has long aging qualities. It is built to take compression and recover as the concrete expands or contracts. The joint strip eliminates the necessity for frequent trimming and resealing. It is not subject to extrusion with the expansion of the concrete, thus assuring a smooth, even surface at all times.

Figure 1 shows a typical cross-section of the Goodrich joint filler in place. It is designed with flexible fins on the two sides which project upward against the concrete surface of the joint opening. In order that the strip may be easily compressed, it is made with a tubular opening in the center. The top surface is slightly indented or grooved to provide for downward thrust of surface upon compression. The filler easily accommodates itself to variations in width of the opening, by compression of the side fins and of the internal hollow space. The natural elasticity and recovery of the live rubber bring the material back to its normal shape as the crack widens during cold weather. In the process of expansion the top of the filler depresses downward so that there is no bulging above the surface of the joint.

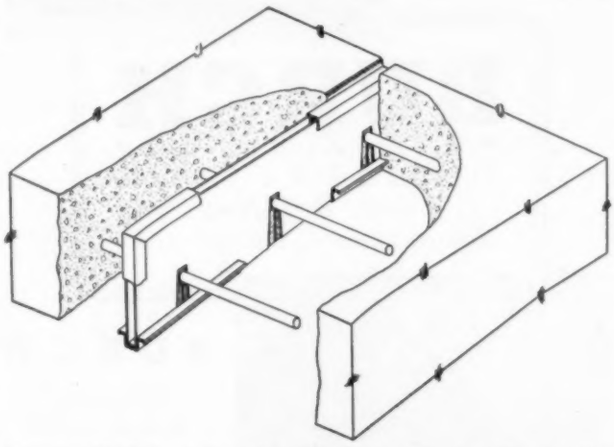


Fig. 2.—Method of Forming Joint Space During Construction.

Preparation of Joint Openings.—Proper installation of the rubber filler calls for joint openings to be made by withdrawing a steel form from the concrete after it is sufficiently hard so that it will not be damaged in the operation. These openings should be no greater than the width specified when finished. The concrete along the sides of the joint openings should be well spaded or vibrated to insure a smooth, sealable surface which is free from honeycomb. The top edges of the joint opening must be edged with a radius tool of ⅛ in. radius for openings ¾ in. or wider and 1/16 in. radius for openings less than ¾ in. wide. The strip is not placed in the openings until the concrete has hardened sufficiently to withstand the compression caused by insertion of the strip. This may mean a period up to 48 hours depending upon weather conditions.

To insure the uniform and smooth concrete surface essential for a satisfactory joint installation, various types of forms may be used for molding the joint opening. One simple but highly efficient design is shown by Fig. 2. It consists of two steel sheets with dowel bar slots and a channel spacer which fits over the top and sides. Inserts of solid rubber are used to fit the dowel bar slots. These inserts prevent concrete from entering the joint opening through the slots and are removed easily after the concrete has hardened. The same function may be accomplished by the use of metal clips or small squares of heavy tar paper.

Methods of Application.—This type of expansion joint filler can be installed in several different ways. The method most generally used for highways, city streets and alleys is that shown by Fig. 1 and involves the use of a dowel joint with a top and bottom seal. The rubber filler strip is placed around the entire perimeter of the joint opening. The result is similar to that obtained with the metal air cushion type of joint. How-

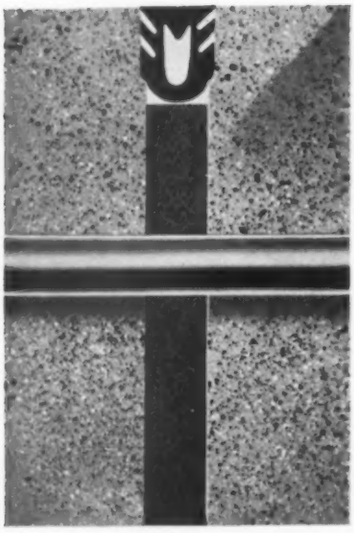


Fig. 3.—Solid Filling May Be Used Part of the Way in the Joint.

ever, the joint design may require the joint space to be partially filled solid with any one of many types of joint fillers, like Flexcell, leaving enough space at the top, as shown by Fig. 3, so a non-extruding rubber seal can be inserted.

For use in joints which have been filled previously with poured or pre-molded material, the original material is removed to a depth of about 1¼ in. and the rubber strip inserted into the space.

▼

15,345 Miles of Highway Improved.—Highway construction of all types administered by the U. S. Bureau of Public Roads during the fiscal year ended June 30, 1938, resulted in the improvement of 15,345 miles, the elimination of 711 grade crossings, reconstruction of 144 obsolete grade-crossing structures, and protection of 744 highway-railroad crossings by signs and signals. Both the amount of work done per mile of improvement, and the total mileage improved considerably exceeded the average rates over the past 10 years.

▼

Holland Building Paths for Bicycles.—Holland, with a population of 8,500,000 people, has 3,500,000 bicycles which pay 30 per cent of the taxation from all transportation units. Bicycle paths 6½ ft. wide are being built along the main roads.

▼

MILEAGE OF FEDERAL-AID SYSTEM

The Federal-aid system was designated as a result of the Federal Highway Act of 1921 and in accordance with the intention of the act there has been close adherence to the original system. Only minor revisions have been made to meet unforeseen conditions. The mileages have been changed slighlty from year to year as estimated mileages or mileages along old roads have been replaced by the measured mileage on new construction.

The original system was limited to 7 per cent of the rural road mileage within each state. When provision has been made for improvement of 90 per cent of the designated system an additional 1 per cent is permitted and further additions are permitted on the same basis. This provision is becoming of increasing importance and has been taken advantage of by 24 States. During the past year the mileage of the system outside of Federal reservations increased by 2,165 miles due almost entirely to extensions beyond the original 7 per cent.

The system in any state may exceed what would otherwise be the limiting mileage by an amount equal to the mileage of the system within Federal reservations. Additions to the system in reservations amounted to 1,320 miles bringing the total additions for the year to 3,485. The following table from the annual report of Thomas H. MacDonald, Chief of U. S. Bureau of Public Roads, shows the system mileages by states on June 30, 1938:

DESIGNATED FEDERAL-AID HIGHWAY SYSTEM MILEAGE AS OF JUNE 30, 1938

State	Mileage of approved routes outside Federal reservations	Mileage of approved routes within Federal reservations	Total mileage of system
Alabama	3,933	...	3,933
Arizona*	1,617	597	2,214
Arkansas	5,029	175	5,204
California*	5,581	555	6,136
Colorado	3,211	514	3,725
Connecticut*	1,046	...	1,046
Delaware*	824	...	824
Florida*	2,479	...	2,479
Georgia	5,654	73	5,727
Idaho	2,549	772	3,321
Illinois*	9,004	8	9,012
Indiana*	5,340	...	5,340
Iowa*	7,703	2	7,705
Kansas	8,670	15	8,685
Kentucky	3,700	6	3,706
Louisiana	2,756	...	2,756
Maine	1,617	4	1,621
Maryland*	2,195	...	2,195
Massachusetts*	1,674	...	1,674
Michigan*	5,729	233	5,962
Minnesota	7,174	291	7,465
Mississippi	3,699	10	3,709
Missouri*	7,975	...	7,975
Montana	4,390	1,058	5,448
Nebraska	5,598	21	5,619
Nevada*	1,760	54	1,814
New Hampshire	968	33	1,001
New Jersey*	1,567	...	1,567
New Mexico	3,275	377	3,652
New York*	9,078	16	9,094
North Carolina*	7,080	507	7,587
North Dakota	7,139	85	7,224
Ohio*	7,109	...	7,109
Oklahoma	6,474	48	6,522
Oregon*	3,272	482	3,754
Pennsylvania*	7,656	108	7,764
Rhode Island*	518	...	518
South Carolina*	4,020	196	4,216
South Dakota	5,803	477	6,280
Tennessee	4,566	66	4,632
Texas*	14,174	127	14,301
Utah*	2,085	146	2,231
Vermont	1,036	...	1,036
Virginia*	4,568	82	4,650
Washington	2,938	404	3,342
West Virginia	2,214	29	2,243
Wisconsin	5,508	133	5,641
Wyoming	3,222	337	3,559
Hawaii	539	...	539
Puerto Rico	858	...	858
Total	216,574	8,041	224,615

*Increased beyond 7 per cent.

EDITORIAL

ON DISCOUNT SELLING

ELSEWHERE in this issue is a letter from a contractor, discussing an editorial in the March issue. Mr. Denison presented a viewpoint on equipment sales policies that certainly is sound and logical.

It occurs to us that a manufacturer or distributor should not take business that does not show him a profit. We know of cases with a government as the buyer, in which sales were made by manufacturers merely to get the equipment inventory value returned.

Day labor never was and never will be as economical as contract work. Manufacturers should help their contractor clientele by demanding full list prices from governments. Government buying on a rental basis is exactly the same as buying on a low payment plan. Therefore the list price of equipment should be burdened by a "carrying" charge.

Present rental-sales policies are unfair because day labor is not economical. Let us quit renting, and sell for a profitable price for cash, to both contractors and governments. There are many concerns who follow this plan successfully. Only a short time ago we talked with a manufacturer who refused $21,000 worth of business rather than sell on a rental basis of so much per ton or per cubic yard of produced material.

The highway field is a stable market. It should not be penalized by price-cutting and chiseling.

▼

NATIONAL HIGHWAY SYSTEM PROPOSED

"TOLL ROADS AND FREE ROADS" is the title of a voluminous report by the Bureau of Public Roads which the President transmitted to Congress on April 27th. In it the conclusion is drawn that a system of transcontinental superhighways cannot be supported by tolls and will not solve any considerable part of the problem of providing adequate highway facilities. This inescapable conclusion was realized by all highway engineers who have had the least contact with national traffic. Since the Bureau was required to report upon a definite proposed system of three east and west, and three north and south, superhighways to be financed by tolls, they could render specific conclusions. The Bureau is to be complimented for having available sufficient factual information from the state-wide highway planning surveys to render a convincing report. The report admits that from a physical standpoint, such a system is entirely feasible, but proves with reasonable assumptions regarding construction costs and motor vehicle operating costs, as well as traffic potentialities, that the proposed system would not come within 50 per cent of being self-supporting if operated as a toll facility.

While the conclusions reached were with reference to the limited question of financial feasibility of transcontinental superhighways and the possibility of toll collections to meet their cost, the Bureau recognized that the report should be constructive, rather than negative in character, and presented a master plan to meet the most urgent highway needs.

The master plan lists five classes of improvement, the first one listed being a recommendation for a system of highways such as ROADS AND STREETS has argued for many years should exist. The five classes are as follows:

1. The construction of a special, tentatively defined system of direct interregional highways, with all necessary connections through and around cities, designed to meet the requirements of the national defense in time of war and the needs of a growing peace-time traffic of longer range.
2. The modernization of the Federal-aid highway system.
3. The elimination of hazards at railroad grade crossings.
4. An improvement of secondary and feeder roads, properly integrated with land-use programs.
5. The creation of a Federal Land Authority empowered to acquire, hold, sell and lease lands needed for public purposes and to acquire and sell excess lands for the purpose of recoupment.

With all but the last of the recommendations, ROADS AND STREETS is in complete accord. There is no doubt that right-of-way problems are handicapping many worthy highway and street construction projects. We agree that highway construction and maintenance organizations should be empowered to acquire, hold, sell and lease lands in order to have efficient and economic control over the street or highway facility. We do not believe, however, that highway land acquisition authority should be vested in a Federal Authority which also controls land purchases or manipulations for all sorts of public improvements.

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BASE IT ON FACTS

ONE plank in the platform of policies of ROADS AND STREETS is the promotion of economically justifiable highway constructoin. With all other values equal, that type of road should be built which can be justified by savings to motor vehicle operation. From this, it follows that if several types can be justified and their traffic carrying capabilities are similar, naturally the lower cost one of the group should receive first consideration.

This thought is recommended for consideration by the newly organized Kansas Highway Federation. Facts speak for themselves. The statewide planning surveys have been gathering factual information for a period long enough now that usable information is available. The proper design of highways to fit the traffic needs will give all parts of Kansas more all-weather roads.

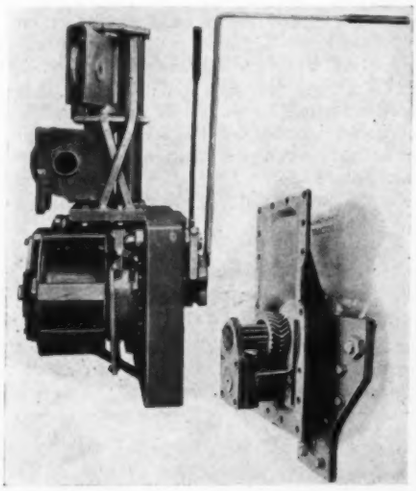
One of the main duties of the Kansas Highway Federation should be a fight to eliminate the diversion of highway funds for other than strictly highway purposes.

Determination of types of construction is not a political problem. Although judging by some things that have occurred in an adjoining state one might easily conclude it is. Economical expenditure of the motorists' gas tax funds requires an engineering study of each project and its relationship to the whole system. The further the Kansas Highway Federation can stay from political influence, the greater service will it render.

NEW EQUIPMENT AND MATERIALS

New Power Control Unit

A new power control unit—the Model T—has been introduced by R. G. LeTourneau, Inc., of Peoria, Ill., and Stockton, Calif. These advantages claimed for this new unit are effected by: (1) an interchangeable neck and gear case, (2) interchangeable drums of varying cable lengths, (3) a new brake assembly, using Timken bearings, that takes the play and slack out of the brake and gives the operator a more accurate hair-trigger control, (4) interchangeable reduction gear sets for the neck—to regulate and control line speeds,



Model T Power Control Unit

(5) an improved brake and clutch assembly that automatically eliminates all brake-drag when the clutch is engaged, (6) "Velvetouch" brake lining for longer wearing, smoother operation (optional), (7) controlled lubrication through a new oil ring, and (8) herringbone gears at vital points for greater power and strength. With the interchangeable neck and gear casing, it is now possible to have one gear case for any size tractor from D4 to D8. One casing and several necks take the place of a full set of complete power control units. Three different cable drum lengths—4, 7⅝, and 14⅝ in.—are available. In addition, LeTourneau power control units feature: free swinging, self-aligning sheaves; upper sheaves that "spool" the cable evenly on the drum; grooves in the steel sheave wheels that are machined to give three side cable support and eliminate abrasive wear; and sheath wheels that are larger than average and run on heavy duty roller bearings.

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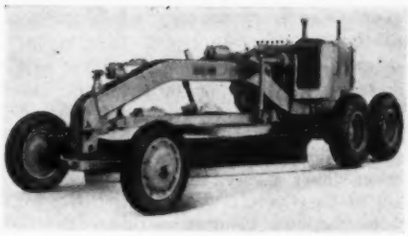
New Heavy Duty Motor Patrol

A new heavy duty motor patrol stated to provide a new and wider range of service has been added to the line of The Galion Iron Works & Mfg. Co., Galion, O. The machine has a one-piece narrow frame giving maximum visibility. It has centralized hydraulic control, adjustments being made at the touch of a lever. It has



Galion Heavy Duty Motor Patrol

a full reversible blade permitting adjustments to every angle. Eight forward speeds and two reverse speeds are provided. The power unit is a 4-cylinder, 4-cycle, water cooled diesel engine, furnishing 66 HP. The approximate shipping weight without scarifier is 21,000 lb. The length over all is 25 ft. 2 in. and the width over all 91 in. The wheelbase is 18 ft. 11 in. The blade is 12 ft. by 22½ in. by ¾ in.

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New Wood Preservative

Development of "Santophen 20," technically described as pentachlorophenol, for preservation of wood, has been announced by Ira Hatfield, plant pathologist in the research laboratories of Monsanto Chemical Co., St. Louis, Mo., following years of research. It is stated that it has been found in tests thus far completed that "Santophen 20," its derivative "Santobrite" (sodium pentachlorophenate), and its formulation "Permatol A" (pentachlorophenol

in an organic solvent) all will protect wood against degrading agents, such as decay and termites. It is stated also that, free from objectionable color and odor, the new preservative can be applied to wood without materially altering the wood's characteristic "feel" or appearance and without affecting subsequent finishing of the wood with paint or other surfacing.

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New Dumper

A new dumper operated by a mechanical winch power-controlled from the cab by the driver of truck has been placed on the market by Speed Dump, Inc., 777 East 138th St., New York City. The outfit, consisting of a nest of five or more steel 2-yd. buckets and a 2-way irreversible worm and gear hoist, is adaptable to any standard truck chassis. In ordinary operation a unit of five or more buckets is placed at strategic working points on the job. The buckets are easily hand-loaded due to their waist height. When the first bucket is filled, it is then hoisted and transported to its destination and dumped. When the truck returns to the job another loaded bucket is waiting. The illustration shows a speed-dumper on the contract of the Corbetta Construction Co. for paving the new Whitestone-Bronx Bridge in New York. The speed dump units meet the pre-mix trucks at the Bronx approach to the bridge. By means of a raised platform the detachable buckets are filled directly from the Corbetta pre-mix trucks. Each speed dump unit going in with an empty bucket spots it for refilling and picks up a filled bucket carrying about 1½ yds. of pre-mix concrete in the 2-yd. standard bucket, which is of solid welded one-piece unit construction, thus preventing any leak of concrete in transit. The speed dump units transport on plywood lanes laid on top of the reinforcing. At the approximate end of each day's anticipated pour, a turn-table has been installed, so that it is only a matter of a few seconds for the speed dump unit to be turned completely around and backed into place for dumping. Three speed dump units are employed on this job.

Speed Dump Unit on Paving Job on Whitestone-Bronx Bridge

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New Lightweight Portable Compressors

A new line of portable air compressors, known as the "Zeph-Air," has been added to the compressor line of the Sullivan Machinery Co., Michigan City, Ind. The new line features compact construction, self starters and refinement of other details to provide extreme mobility and ease of operation. Two sizes are available with capacities of 60 and 85 cubic feet per minute, respectively, of delivered air. Although these compressors have capacity to operate concrete breakers and rock drills, they are so small and compact that the two-wheel mountings can be towed by a pleasure car and the skid-mounted models can be mounted in the body of standard pick-up trucks.

Sullivan "Zeph-Air" Compressor

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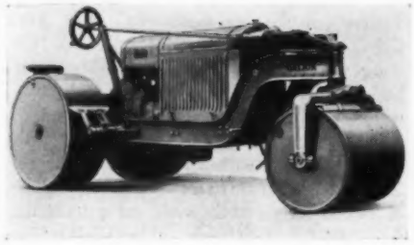
New 4 to 5 Ton Roller

A new light weight roller has been added to the line of The Galion Iron Works & Mfg. Co., Galion, O. The basic weight 4 tons but it can be increased up to 5 tons by the addition of water ballast in the three rolls. Power is provided by an International I-30 engine which develops 39 HP. The rear rolls are 42 in. in diameter and 18 in. wide. The front or steering roll is 30 in. in diameter (two sections used), total width 32 in. The rolling width is 63½ in. high and the compres-



Galion International Roller

sions are as follows: Rear roll: drained weight, 149 lb. per inch; ballasted weight, 182 lb. per in. Front roll: drained weight, 92 lb. per inch; ballasted weight, 110 lb. per inch.

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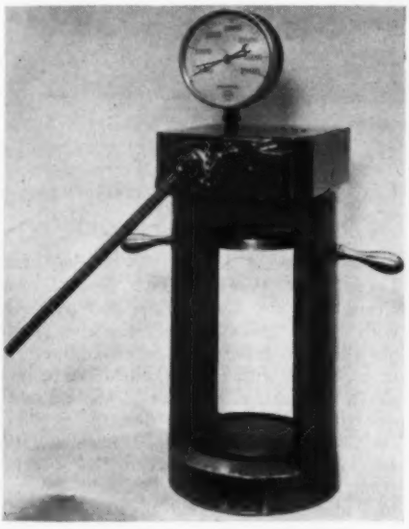
New Portable Testing Machine

A new portable hydraulic compression machine designed especially for the testing of 6 in. x 12 in. concrete cylinders on the site has been placed on the market by Tinius Olsen Testing Machine Co., 500 North 12th St., Philadelphia, Pa. The machine weighs but 265 lb., and can be transported easily from one job to another on a light truck or passenger car.



New Testing Machine

Load is applied to the specimen by a hand-operated hydraulic pump. Readings of the load are obtained from a good grade hydraulic bourdon tube gauge. The upper platen has spherical adjustment to take care of any unevenness in the ends of the specimen. A maximum hand is furnished to indicate the breaking load of the specimen, when the indicating pointer returns to zero upon release of pressure.

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New Rule

An extra sturdy 6-ft. folding wood rule designed to overcome the complaint that such rules break easily, has been placed on the market by The Lufkin Rule Co., of Saginaw, Mich. It has tough, hardwood sections of extra thickness, ⅛ in., making it not only more durable but more rigid. The smooth-working spring joints are brass plated and have patented locks, maintaining accuracy. This rule has brass strike plates, preventing wear of sections in opening and closing. The 6-in. hardwood sections have a special finish, giving them a uniform, light, boxwood color, so the black markings are easy to read.

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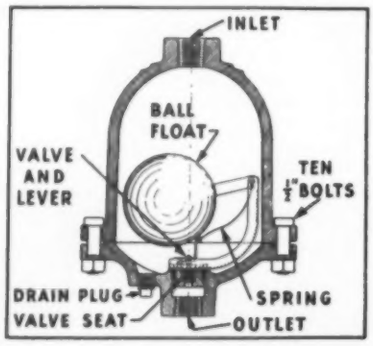
New Electrode for A. C. Transformer Welders

A new arc welding electrode for use with alternating current transformer type welders which have low open circuit voltage, has been brought out by The Lincoln Electric Co., Cleveland, O. The new electrode, known as "Readyweld," is a low-carbon steel rod with a heavy extruded shielded arc coating possessing properties which are stated to assure arc stability and easy re-striking of the arc with small low-voltage transformer welders. "Readyweld" is intended for general welding and repair work on light gauge sheet steel. The electrode provides weld metal which possesses high strength and ductility. Although dsigned primarily for use with alternating current transformer welders of low open-circuit voltage, "Readyweld" also operates well with direct current negative plants. The electrode is manufactured in 3/32-in. diameter, 12-in. lengths, packed in 25-lb. containers.

New Air Trap

A new automatic "snap-action" mechanical trap for draining water from compressed air lines, tanks, separators, and aftercoolers has been placed on the market by the Armstrong Machine Works, 859 Maple St., Three Rivers, Mich. The principal advantages claimed for the device are immunity to ordinary dirt troubles, ability to discharge water without any loss

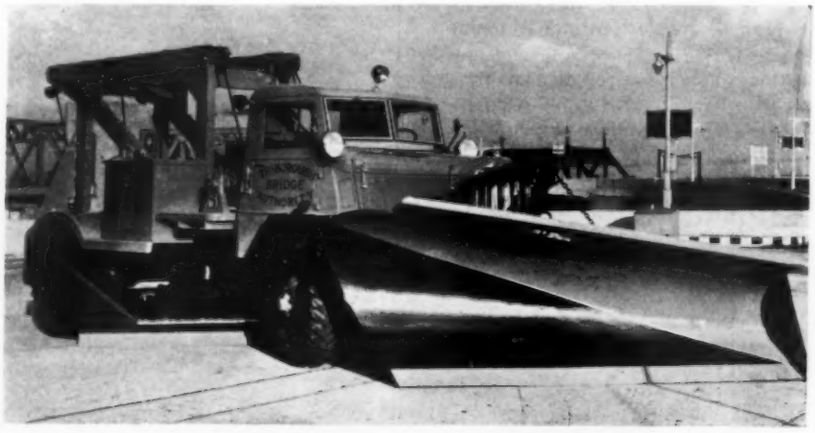


New "Snap-Action" Air Trap

of air, positive opening and closing of discharge valve, and freedom from need for priming. As shown in the cross-section diagram, the trap has a ball float which is connected to the short valve lever through a flat strip of stainless spring steel. In the closed position, this spring is bowed downward. As water enters the body of the trap, the ball float rises—bending and storing up energy in the spring. Just before the ball float reaches the top of the trap, the spring bends past dead-center and the stored-up energy snaps the valve wide open. In this position, the spring is bowed upward. As the water level drops in the trap body, the cycle is reversed and the valve snaps shut. It is this quick, forceful closing that prevents pieces of dirt from getting lodged in the valve and causing leakage. The capacity claimed by the maker is 1400 lb. of water per hour at 125 lb. pressure and 1000 lb. per hour at 250 lb. pressure.

Combination Snow Fighter and Wrecker

A new type of combination snow fighter and wrecker was delivered recently to the Triborough Bridge Authority, New York City, by the Walter Motor Truck Co., Ridgewood, L. I., N. Y. This unit will be used for snow removal and as a wrecker truck on the Triborough and the new Whitestone bridge, which will probably be opened within the next few weeks. The double drum winch has a capacity of 14,000 lb. on each cable, or a total lifting capacity of 14 tons. The Walter four point positive drive, 125 H.P., has the power and traction to haul the heaviest crippled vehicles under all conditions. An important feature of the plow is the center scraper blade for the removal of packed snow and ice to prevent the formation of ice ruts.



Walter Snow Fighter Wrecker Owned by Triborough Bridge Authority

New Truck Crane

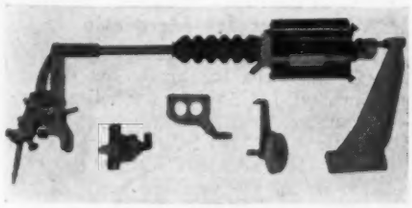
The Type 34 Paymaster of the Lima Locomotive Works, Inc., Shovel and Crane Division, Lima, O., is now available with motor truck mounting. The power plant is a 6-cylinder gasoline engine, 4⅛ in. x 4¼ in. with silent chain drive to jack shaft. A diesel engine can be applied when desired. The general design embodies such important features as modern anti-friction bearings at every vital bearing point, including drums. Weight is kept to a minimum by taking advantage of high tensile steel and placing machinery to extreme rear of revolving frame. Special attention has been given to the comfort of

Lima Truck Crane Owned by Harris Structural Steel Co., New York City.

the operator. The levers which control the various operations are all located within the cab and are of short easy throw. To further increase the comfort of the operator, an extra wide bus type seat is provided. The wide vision cab is equipped with a winter front. The winter front is so designed that it can be housed in the top of the cab when not in use and is easily lowered or raised with one hand. The rotating frame upon which the main machinery is mounted is cast in one piece. This is standard Lima practice. All tendency of the rotating frame to lift away from the base or turntable is eliminated by the use of hook rollers which rotate between a double integral roller path. The base casting or turntable is securely bolted and welded to the truck chassis which is thoroughly reinforced to withstand the shocks imposed upon it. The boom hoist is a separate unit mounted on the rotating base casting and is independent in operation. The raising or lowering of the boom is independent of all other functions and is accomplished through an internal expanding friction clutch and lowered by means of a friction brake. For additional safety a ratchet and dog is provided which is controlled from the operator's station. For special crane service a worm driven boom hoist can be had at a slight additional cost. The standard crane boom is 35 ft. long and is made in two sections of alloy steel cord angles. The two sections are pin connected which eliminates the use of bolts and reduces time and effort when inserting sections to form longer booms.

Improved B-K Power Braking

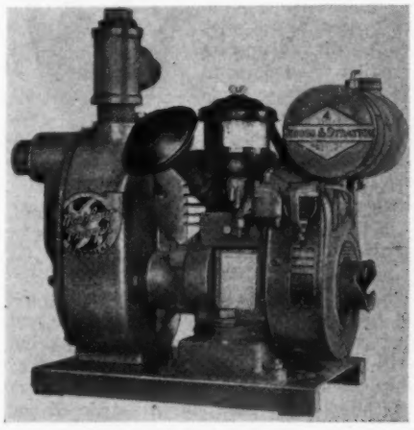
Chief feature of the new B-K Power Braking for 1939 Ford and Chevrolet trucks, as announced by Bendix, is the reactionary vacuum suspended cylinder. The reactionary cylinder is an internal valve type which eliminates the necessity of the conventional external valve and valve lines. This system is stated to maintain "pedal feel," so that the driver knows precisely how much braking power he is applying and can thus avoid sudden lock-wheel stops. This design, furthermore, adds less weight to the vehicle and has fewer parts. The location of the operating valve within the cylinder provides protection from road splash and other foreign elements. Another advantage of B-K design, stressed by Bendix, is that it leaves the original brake system intact. Utilizing otherwise wasted manifold vacuum, it subtracts nothing from the engine power, and adds no burden to the battery or the generator. It is of such design that the brakes can be applied without the assistance of the power unit, by exerting the same pedal pressure as was necessary before the system was installed. The vacuum brake system provides a double safety factor—power actuation plus manual actuation. This new B-K controlled vacuum power brake system for Fords and Chevrolets can be used in connection with any vacuum trailer brake system by adding the necessary accessories and fittings obtainable as complete packaged kits. When used in connection with trailer operation, it complies with all state laws and other regulations including the "break-away" clause demanding 15-minute holding of trailer brakes in case of separation.



New B-K Power Braking System

New Light Weight Pump

A new light weight self-priming centrifugal pump has been brought out by Marlow Pumps, Ridgewood, N. J. The pump is made in two models, aluminum, weighing 60 lbs. and cast iron weighing 76 lbs. The pump has a bronze open type impeller, and the pump shell is self

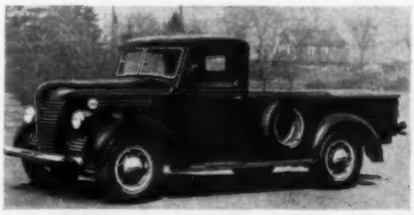


Marlow 1½ In. Self Priming Centrifugal Pump

cleaning. There are no moving parts in the pump except the impeller and shaft. The suction and discharge are 1½ in. and the capacity rating is 3,000 gal. per hour. The maximum suction lift is 25 ft. and the maximum total head including lift and pipe friction is 55 ft.

New ¾-Ton Trucks

The Federal Motor Truck Co., Detroit, Mich., has entered into the low price light-duty field with two new models rated at ¾-ton. A choice of 4 or 6 cylinder engines is offered. The model 7 is built with a 4-cylinder engine with bore and



New ¾-ton Federal Equipped with Deluxe Cab and Standard All-Steel Pick-Up Body Which Is Available in Three Lengths, 7, 8 and 9 ft.

stroke of 3 3/16 in. x 4 3/8 in. which develops 52 H. P. The model 8 is offered with a 6-cylinder, 7-bearing engine with 3¼ in. bore and 4⅛ in. stroke, develop-

ing 65 HP. Both engines are designed especially for truck service. Except for the difference in the engines both models are identical in design and construction. A front end of unusually pleasing and modern style distinguishes the new models as very attractive appearing vehicles. Extra sturdy construction designed to give long life and low upkeep cost is claimed for these Federal chassis. They are built in four wheelbase lengths, 102-in., 111-in., 119-in. and 128-in. Five standard bodies in various lengths are offered for the new light-duty Federal models.

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New Metal Pile Shoe

A new metal pile shoe for protecting the ends of wood pile and preventing booming has been placed on the market by The Union Metal Mfg. Co., Canton, O. The shoes are available in two sizes to fit piles with tip diameters ranging from 5 in. to 14 in. They are made from heavy gauge rolled steel, formed in two sections and electrically welded together. When driving wood pile through shale, gravel, rip-rap rock or other difficult soil conditions, it is claimed that the use of these metal shoes will not only prevent the ends of the piles from booming but will enable the piles to be driven further into the ground in quicker time. The shoes are attached to the roughly sharpened end of the pile through the nail holes in each wing. According to the manufacturer, the wings can be easily bent with a hammer to conform to the shape of small diameter tips.

New Pile Shoe of Union Metal Mfg. Co.

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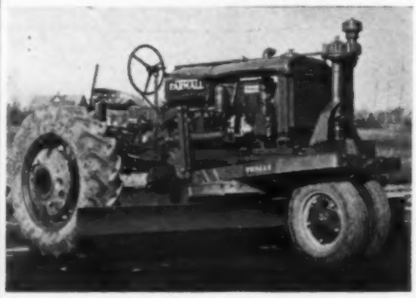
New Maintainer

A new maintainer designed particularly to serve as a low cost tool for maintaining dirt and gravel roads, scraping and leveling shoulders and performing light grading operations has been brought out by the Contractors Machinery Corporation, Batavia, N. Y. This tool is a one man outfit, all operations of the maintainer unit being completely at the control of the operator from his seat on the tractor. All movements are effected through power hydraulic "finger-tip" control. A 9 ft. blade attached to a swinging circle forms the basis of construction of this tool. The vertical movement of the blade is controlled through power hydraulically operated twin two-way rams, which permits power to be applied either up or down. The angle of the blade is controlled by a "dog" in the swinging circle, which is operated by a lever conveniently located for the tractor operator. To change the blade angle, it is necessary only to release the dog and swing the blade on the circle to any desired position by the motion of the tractor. The International "F-20" motor supplies adequate power and the additional weight of this size tractor plus the maintainer unit assures sufficient poundage to hold the machine to its work.



The Trojan Maintainer

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WITH THE MANUFACTURERS

Quincy A. Campbell Dies

Quincy A. Campbell, 47, Assistant Chief Engineer of the National Paving Brick Association, Washington, D. C., died at the Cleveland, O., Clinic on April 19. He was buried on April 22 at Bellefontaine, O., his birthplace, from the home of his mother, Mrs. C. D. Campbell. Mr. Campbell was born in 1891. He was graduated from the Ohio State University in 1920 with the degree of Bachelor of Civil Engineering. During the World War, he served as instructor in the aviation ground school at the university and at Kelly Field, Texas. After receiving his discharge from the army in 1919, he became assistant engineer for the city of Hamilton, O. After spending a year in engineering work in the Republic of Santo Domingo, he joined the Ohio department of highways in 1921 as assistant engineer. During the following seven years he served the department as assistant division engineer at Ravenna and as assistant chief engineer of maintenance, with headquarters at Columbus. In July, 1928, he resigned from the Ohio department to accept the position with the National Paving Brick Association which he held at the time of his death. Mr. Campbell's activities included the past presidency of the Ohio State University Alumni Association of Washington and membership in the Triangle fraternity. Until recently, he also belonged to the National Press Club and the National Press Club Post of the American Legion.

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Lincoln Electric Co. Opens Duluth Office

The Lincoln Electric Co., manufacturer of arc welding equipment, Cleveland, O., has opened a new office in Duluth, Minn., at 222 South 21st Ave., East. A stock of electric welders, electrodes and supplies will be maintained for serving the Duluth area. Mr. I. R. Bartter, formerly with the Minneapolis office of the company, is in charge of the new branch.

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Witt Appointed Technical Service Manager for Marquette

The Marquette Cement Manufacturing Co., Chicago, Ill., has announced the appointment of J. C. Witt as technical service manager, with headquarters in the Marquette Bldg., 140 South Dearborn St., Chicago. His activities include the correlation of all the technical work of the company. Mr. Witt is an engineer (M. E.), and holds a Ph.D. dgeree in chemistry and physics. For a number of

years he has specialized in the manufacture and use of cements and other materials of construction—having been at various times chemical engineer, plant superintendent, director of research, and consultant. He is a member of the American Society of Mechanical Engineers, the American Institute of Chemical Engineers and many other technical organizations.

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Ethyl Buildings Testing Laboratory at San Bernardino

Anticipating an unprecedented advance in automotive science and petroleum chemistry during the next decade, the Ethyl Gasoline Corporation has just completed an engineering laboratory at San Bernardino, Calif., in order to extend its facilities for cooperative research with oil and automotive companies. From this new center, located in a mountainous and desert area constituting a great natural proving ground which contains a variety of road conditions that approximate most of those encountered in the United States, the Corporation's engineers will carry out a unique program of research on engines and fuels. The San Bernardino Laboratory will supplement the work of the Ethyl Engineering Laboratory at Detroit. Among the many facilities there is included a gasoline testing laboratory, one of several which the Ethyl Corporation operates throughout the country.

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J. S. Witt Made Technical Service Manager for Marquette

The Marquette Cement Manufacturing Co., Chicago, Ill., has appointed J. C. Witt as technical service manager, with headquarters in the Marquette Building, 140 South Dearborn St., Chicago. His activities include the correlation of all the technical work of the company. Mr. Witt is an engineer (M.E.), and holds a Ph.D. degree in chemistry and physics. For a number of years he has specialized in the manufacture and use of cements and other materials of construction—having been at various times chemical engineer, plant superintendent, director of reserach, and consultant. He is a member of the American Society of Mechanical Engineers, the American Institute of Chemical Engineers and many other technical organizations.

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New Distributors for Ransome

The Ransome Concrete Machinery Co., Dunellen, N. J., manufacturers of the Ransome line of concrete mixers, pavers, and truck mixers, have announced the appointment of Earl Walker Co., Inc., Sullivan, Ill., to handle the line of small mixers, sizes 3½-S to 14-S inclusive, in the nearby counties in Illinois surrounding Sullivan—and O. B. Kramp, Coral Gables, Fla., to handle their complete line in the nearby counties in Florida surrounding Coral Gables.

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Albert E. Webster Dies

Albert Ellis Webster, assistant publicity manager of Universal Atlas Cement Co., with which company he had been associated for 15 years, died suddenly April 22 at his home in Jackson Heights, Long Island, N. Y., to which residence he moved last fall from River Forest, Ill., where he had lived for many years. Mr. Webster held a Ph.B. degree from Alfred (N. Y.) University and a D.B. degree from the University of Chicago. For a number of years before he joined the cement company he was interested in social service work and wrote several books and articles on that subject. He was 59 years old and is survived by his widow Lilian, whom he married June 12, 1907; two sons, Paul of River Forest, Ill., and Victor of Chicago, Ill., and a daughter, Mrs. Theresa Gielow of Detroit.

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Link-Belt Company Acquires Speeder Machinery Corporation

Consolidation of Speeder Machinery Corporation, Cedar Rapids, Ia., manufacturers of ⅜ yd. to ¾ yd. power operated excavating and materials handling shovels, draglines, cranes, and the Shovel Division of Link-Belt Co., has been announced by Alfred Kauffmann, President of Link-Belt Co., Chicago. For the present each organization will continue to operate independently. The merger consolidates the products of these two well known manufacturers into a complete line of shovels, draglines, cranes ranging from ⅜ yd. to the 2½ yd. crawler-mounted units. This change also makes available to the Speeder Machinery Corporation a full size range of Link-Belt locomotive cranes. Combined facilities and full control of all sales and manufacturing operations are expected to benefit both production and distribution. Speeder Machinery Corporation will be operated as a subsidiary of Link-Belt Co. with the present management continuing to operate the business. T. M. Deal will continue as president.

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New Omaha, Neb., Distributor for Bucyrus-Erie

The Fuchs Machinery & Supply Co., of 1102 Farnam St., Omaha, Nebr., have been appointed distributors for Bucyrus-Erie Co. in their territory. They will handle Bucyrus-Erie shovels, draglines and buckets, clamshells, lifting cranes and dragshovels ranging from ⅜-yard to 2¼-yard size.

▼

Barton, Inc., Appointed Distributor for Bucyrus-Erie

The Quinn R. Barton, Inc., of 1305 West Forsyth St., Jacksonville, Fla., have closed with the Bucyrus-Erie Co., South Milwaukee, Wis., builders of excavating machinery, to represent them in their territory where they will handle Bucyrus-Erie shovels, draglines and buckets, clamshells, lifting cranes and dragshovels ranging from ⅜-yard to 2¼-yard size.

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Great Lakes Supply Corp. Appointed Distributor for Bucyrus-Erie

Bucyrus-Erie Co., of South Milwaukee, Wis., builders of excavating machinery, have appointed the Great Lakes Supply Corporation, 324 W. 36th St., Chicago, Ill., as distributor in their territory where they handle Bucyrus-Erie shovels, draglines and buckets, clamshells, lifting cranes and dragshovels ranging from ⅜-yard to 2¼-yard size.

J. R. Burkey Now with Union Metal Mfg. Co.

J. R. Burkey, formerly chief engineer of bridges of the Ohio State Highway Department, has joined the Union Metal Manufacturing Co., Canton, O., as consulting engineer specializing in steel piling for foundations. Mr. Burkey was born in Ohio (Muskingum County) and was graduated from Ohio State University in 1908 with a C.E. degree. Following graduation he taught engineering for one year at New Mexico Agricultural College and for two years was engaged in railroad and highway location and construction in Oregon and Washington. Returning to Ohio in 1911 he became the first division engineer of bridges in the newly organized highway department. With the exception of two years, when he served as professor of structural engineering at Ohio State University, he has been associated with the bridge bureau of the state highway department, serving as chief engineer for the past 14 years. Under his leadership, bridge engineering in Ohio has reached a high standard as evidenced by the recognition many designs have received in engineering literature. Also under his jurisdiction railroad grade separation work has received like recognition. Mr. Burkey has taken an active interest in the problems involved in foundations for structures. In cooperation with Professor Clyde T. Morris of Ohio State University and Mr. K. V. Taylor, he carried on the research covered by Bulletin No. 90 of the Engineering Experiment Station of the University, entitled "The Predetermination of Piling Requirements for Bridge Foundations," which is pioneering work in this difficult field. Aside from the technical aspects of his work, Mr. Burkey has given much of his time to the welfare of the engineering profession. He was distinctly honored by his fellow engineers in his elevation to the presidency of the Engineers' Club of Columbus and to the Presidency of the Ohio Society of Professional Engineers. Mr. Burkey will maintain his office in Columbus.

J. R. Burkey

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F. L. Dake Announces His Retirement

F. L. Dake, for the past 21 years an executive of The Foote Company, Inc., Nundo, N. Y., has announced his resignation as secretary and treasurer of the corporation. Mr. Dake has had the matter of retirement from active service under consideration for well over a year, but was persuaded to remain active the past year by the management. For a period of 33 years, Mr. Dake has served the company in various capacities and for the past 21 years has been secretary and treasurer of same, and the organization, its many agents and salesmen throughout the country as well as the industry which he has ably served, will miss him very much in their contacts, but will rejoice in that his retirement from active service during the prime of his life will permit of a long and very much deserved rest. Mr. Dake has devoted his entire business life to the paver industry and contributed in a very great measure to the success of The Foote Company, Inc., which he has seen grow from a very meager beginning to one of the dominating factors of the industry as a whole. The Foote organization is losing a strong character and his very loyal and able counsel and efforts will always be greatly appreciated and his decision to retire at this time is one of regret on the part of his associates and the management.

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Celebrating 80th Anniversary

Hewitt Rubber Corporation, Buffalo, N. Y., manufacturer of hose, conveyor, bucket elevator and transmission belting, and packings, is celebrating this year the 80th Anniversary of the founding in 1859 of the Gutta Percha and Rubber Mfg. Co., Hewitt parent company.

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E. A. Johnston, IHC Vice President, Retires

Retirement of Edward A. Johnston, vice president in charge of engineering and patents of the International Harvester Co., and one of the nation's best known agricultural and automotive engineers, has been announced by Sydney G. McAllister, president of the Harvester Company. Mr. Johnston, a veteran of 50 years in the industry, spent 45 years with the Harvester Company or its predecessors. He will be succeeded as vice president in charge of engineering and patents by A. W. Scarratt, who has been assistant to Mr. Johnston since 1936. No man of his times exerted a greater influence than Mr. Johnston on the design and construction of farm machines. In the 41-year period from 1897—when as a young man of 22 he was granted his first implement patent—down to 1938 he was granted a total of 171 patents on farm implements and the allied lines of tractors and motor trucks. In this list are to be found patents on practically every important farm implement. In 1938, in honor of his outstanding accomplishments as an agricultural engineer, Mr. Johnston was granted the Cyrus Hall McCormick medal of the American Society of Agricultural Engineers in recognition of his contribution to the engineering profession.

Mr. Scarratt has had wide experience in the fields of automotive and agricultural engineering. Born at St. Paul, he began his engineering career with the Twin City Rapid Transit Co. and was in the employ of that concern from 1905 to 1913. From 1913 to 1926 he was successively designer, tractor engineer, and chief engineer of the mechanical division of the Minneapolis Steel and Machinery Co. In 1926 he was engaged as assistant chief engineer of the Hyatt Roller Bearing Co. and was soon promoted to chief engineer. In 1927 he was engaged as chief engineer of motor trucks and coaches by the Harvester Company. In 1935 he was promoted to be chief of automotive engineering, and in 1936 became assistant to the vice president of engineering.

Engineer, 30 years old, American born, and single, desires position with an engineer or organization which can utilize his training and experience. Has B.S. degree in engineering, 4 years experience in highway construction, 3 years in industrial engineering and building construction work, and one year of accounting and plant management. Address Box 444, Roads and Streets, 330 S. Wells St., Chicago, Ill.

NEW LITERATURE

Construction Data—A new construction data handbook for highway engineers and contractors has been issued by the Barber Asphalt Corporation, Barber, N. J. It contains many tables and much useful data as well as specifications for the use of Trinidad products. Among the information included in the book are directions for unloading tank cars, design features for agitation equipment in cylindrical and rectangular tanks, many useful tables of coverage for tank distributors, stone and asphalt, and tables of linear and land measure, cubic or solid measure.

LeTourneau Methods—This is the name of a bi-monthly publication dedicated to the interests of lower costs and more efficient construction methods, recently introduced by R. G. LeTourneau, Inc., of Peoria, Ill. In it the means of handling varied jobs in the fields of construction, lumbering, mining, and kindred industries are emphasized, explained, and illustrated.

Tractors, Graders, Engines.—A composite catalog, covering the entire "Caterpillar" line, has been issued for 1939 by Caterpillar Tractor Co., Peoria, Ill. Illustrated profusely with model photographs and cutaways to show mechanical features, the booklet gives brief specifications and operating data about every product built by the company. Track-type tractors, auto patrols, blade graders, elevating graders, terracers, diesel industrial engines, diesel marine engines and diesel electric generator sets are all included. The catalog is divided into three sections, the first dealing with tractors; the second, road machines; and the third, diesel engines.

Construction and Maintenance Machinery.—"Machinery for Construction and Maintenance of Roads and Streets" is the title of new catalog No. 32 issued by the White Manufacturing Co., Elkhart, Ind. This booklet gives a complete description of the White Company line of aggregate dryers, bituminous repair truck, asphalt plants, asphalt and tar heating kettles, concrete vibrators, kerosene torches, concrete mixer and hot water heaters, power rollers and other equipment.

Diesel Engines.—Worthington Pump and Machinery Corporation, Harrison, N. J., has issued new literature describing its new type CC totally enclosed, direct-injection Diesel engine. Of the 4-cycle, trunk-piston type, using a direct fuel-injection system, the new engine is of the simplest and most compact design consistent with high efficiency and complete accessibility. All moving parts are wholly enclosed.

Trailer Type Crushers.—The Universal Crusher Co., Cedar Rapids, Ia., has issued Bulletin No. 11 covering their line of trailer type crushers. These crushers are for tractors with rear power take-off and are used by contractors and highway departments for crushing hand-fed material from stock piles or windrows along the road to be surfaced.

Compressors.—A new 28 page catalog on its line of "ES" compressors has been published by the Ingersoll-Rand Co., 11 Broadway, New York. These machines, built in sizes from 10 to 125 h.p., and pressures from 5 to 2500 lbs., are of the double-acting, horizontal, crosshead type, designed to run at moderate speeds on heavy continuous service. Four pages of the catalog are devoted to illustrations of installations, exemplifying service in several different industries.

Guard Cable Splice—A publication on its wedge type union cable splice has been issued by Malleable Iron Fittings Co., Pole Hardware Department, Branford, Conn. This splice is for standard 3-strand, 7-wire, ¾-in. cable. This splice is now used regularly in seven states and is acceptable in others. Ask for Data Sheet No. H-1.

Mixers, Pumps, Hoists, Saw Rigs, Etc.—A new catalog dealing with its line of concrete, bituminous, plaster and mortar mixers, self-priming pumps, hoists, saw rigs, wheelbarrows, concrete carts, and builders' equipment has been issued by the Construction Machinery Co., Waterloo, Ia. The catalog is attractively gotten up and profusely illustrated. The equipment is illustrated and described and specifications are given.

Elevating Graders—A 20-page catalog illustrating and describing its elevating graders has been issued by J. D. Adams Co., Indianapolis, Ind. The various features of the grader are illustrated and described in detail. In addition specifications are given as well as numerous job illustrations.

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CHICAGO, ILLINOIS

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THIS MAGAZINE IS DEVOTED TO
Design, Construction and Maintenance of Highways, Streets, Bridges and Grade Separations

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C. T. MURRAY
Managing Editor
J. C. BLACK
Field Editor
D. G. LEDGERWOOD
Advertising Editor

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REPRESENTATIVES

Chicago Office
E. C. KELLY
L. H. LINGNOR
330 S. Wells St., Chicago, Ill.
Telephone: Harrison 1843

New York Office
J. M. ANGELL, JR.
155 East 44th St., New York, N. Y.
Telephone: MUrrayhill 2-6023

Cleveland Office
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 Acceptance under the Act of June 5, 1934, authorized January 25, 1938, at Chicago, Illinois. Subscription price $3.00 per year in the United States, $4.00 per year for foreign mailing.

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